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\$ 4.60

405 134

(4) NA

(5) 734 000

(7-9) L/A

(11) 15 Apr 63,

(12) 42p.

(13-17) L/A

(18) REIC

6335
April 15, 1963

REIC Accession List 62

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RADIATION EFFECTS INFORMATION CENTER

(6) MONTHLY ACCESSION LIST,
ABSTRACTS,
PART I.

(19) ALJ 62

(20) U

(21) NA

734 000

RADIATION EFFECTS INFORMATION CENTER

BATTELLE MEMORIAL INSTITUTE

505 King Avenue

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April 15, 1963
REIC ACCESSION LIST
Number 62

MONTHLY ACCESSION LIST

By: Radiation Effects Information Center

Dates Covered: March 1, 1963 to March 31, 1963

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18001

R. L. Pearson, F. R. Standerfer, H. J. Snyder, H. T. Watanabe,
L. G. Carpenter, and R. I. Miller

HYDRAZINE PROCESS DEVELOPMENT

Aerojet-General Nucleonics, San Ramon, Calif., ASD-TR-7-840A

(VI), Interim Tech. Engineering Rpt., May - July, 1962,

AF 33(600)-42996, 173 pp

Avail: ASTIA

This report describes gas disengager, evaporator, materials test loop, and slurry capsule tests. The use of evaporation, distillation, and molecular sieves as hydrazine-ammonia separation techniques is described. Design of support systems for the in-reactor loop is presented. The fission-chemical production of UF_3 is reported. Evaporative and molecular sieve separation experiments began; a distillation column was designed to concentrate the in-reactor loop product stream. Hydrazine was separated from a crude, radioactive product with a fission fragment decontamination factor of about 10^5 . Materials test loop operations showed that slurry-free, ammonia-hydrazine solutions were stable for up to 180 hours; that adding urania particles causes slow hydrozine decomposition; and that mechanical break-up of urania particles occurs. Slurry irradiation capsules were made and tested; irradiations to fuel burnups of .005, .01, and .03 per cent began. Ammonia make-up, loop clean-up, demineralized water, and hydrogen removal systems are being designed to support in-reactor loop operations. Photobleaching, radical scavenging, and N^{15} -labeled hydrazine techniques will be used to delineate mechanisms of hydrazine formation. Uranyl-8-hydroxyquinolate, initially soluble in ammonia, undergoes slow ammonolysis to an insoluble product. Fission fragment energy deposition efficiencies of thin plate, U-Al sources were determined with the solid-state detection device. A high-energy oxidizer, NF_3 , was produced with a G-value of about 0.5 by the fission-chemical irradiation of an N_2-F_2 gaseous mixture.

18002

Kaichi Maeda

ON THE HEATING OF THE POLAR UPPER ATMOSPHERE

NASA-Goddard Space Flight Center, Greenbelt, Md.,

NASA-TR-R-141, 1962, Tech. Rpt., 62 pp

Avail: NASA

On the basis of the atmospheric composition given by F. S. Johnson in 1960, the contribution of auroral particles to the dissociation of oxygen molecules in the polar upper atmosphere is investigated. The maximum rate coefficients are $4 \times 10^{-8} \text{ (cm}^3 \text{ sec)}^{-1}$ and $2 \times 10^{-8} \text{ (cm}^3 \text{ sec)}^{-1}$ for protons of energy spectrum E-2.8 dE and for electrons of energy spectrum E-4 dE, respectively. The height of maximum dissociation is around 90 km both for protons and electrons. The heating of the polar mesosphere by exothermic association of the oxygen atoms, intensified by the subsidence of the upper polar atmosphere during the polar night, is calculated and found to be close to the estimate given by W. W. Kellogg in 1961. The investigation indicates, however, that Kellogg's estimate should be reduced slightly to allow for the cooling effect produced by far infrared emission from atomic oxygen in the upper atmosphere.

18003

B. J. O'Brien, J. A. Van Allen, C. D. Laughlin, and
L. A. Frank

ABSOLUTE ELECTRON INTENSITIES IN THE HEART OF THE EARTH'S
OUTER RADIATION ZONE

State University of Iowa, Dept. of Physics and Astronomy,
Iowa City, Iowa, SUI-61-23, NASw-17, 18 pp
Avail: NASA, N 62-10831

By means of a two channel magnetic spectrometer, a set of CdS energy flux detectors, and two Geiger-Mueller tubes with different shielding in the NASA satellite Explorer XII, whose apogee is at 13 earth radii, the following absolute omnidirectional intensities of electrons of energy E are reported as typical of high intensity conditions in the heart of the earth's outer radiation zone (September 5, 1961): (1) $45 \text{ kev} < E < 60 \text{ kev}$, $(9 \pm 16) \times 10^7 \text{ (cm}^2 \text{ sec)}^{-1}$ (2) $80 \text{ kev} < E < 110 \text{ kev}$, $(8 \pm 16) \times 10^7$ (3) $110 \text{ kev} < E < 1.6 \text{ Mev}$, less than 10^8 (4) $1.6 \text{ Mev} < E < 5 \text{ Mev}$, $(2 \pm 1) \times 10^5$ (5) $E > 5 \text{ Mev}$, less than 10^3 . The omnidirectional intensity of electrons of energy greater than 40 kev is thus of order $10^8 \text{ (cm}^2 \text{ sec)}^{-1}$, a value much lower than the tentative value 10^{11} in 1959 on the tentative assumptions that the suggested response of a G-M tube shielded by $\sim 1 \text{ g cm}^{-2}$ of intermediate Z material was due dominantly to non-penetrating electrons of effective energy in the tens to hundreds of kev.

18004

Richard Lansing Geer

IMPACT STUDIES ON LUNAR DUST MODELS AT VARIOUS VACUUMS

Wright-Patterson AFB, Aeronautical Systems Div., O.,
ASD-TR-61-595, Jan., 1962, Tech. Rpt., 69 pp
Avail: ASTIA, AD 273604, OTS

An analysis of the factors relevant to lunar environmental simulation show that the dynamic behavior of lunar dust models in various vacuums must be studied to establish the degree of vacuum required of a lunar simulator. Various silica and basaltic rock dusts were selected as lunar dust models and tested under a range of vacuums. Although crater width measurements indicate lunar dust models do not change their resistance to impact at vacuums beyond $1 \times 10^{-3} \text{ mm Hg}$, depth of penetration measurements do show a continuous change in resistance up to $1 \times 10^{-5} \text{ mm Hg}$, the limit of the test. The behavior of lunar dust particles depended upon both particle size distribution and particle microstructure. The effects of hold times at vacuum, container walls, dust shallowness, and the composition of the residual atmosphere on dust behavior are analyzed. Recommendations are made for follow-up studies.

18005

Keith W. Ogilvie

SOLAR PROTONS

NASA-Goddard Space Flight Center, Greenbelt, Md., NASA-
TN-D-1139, July, 1962, Tech. Note, 35 pp
Avail: NASA

A good deal of attention has been given to experimental studies of particles accelerated by the sun during solar flares. This report examines the state of experimental knowledge and the methods used to study solar protons. An account is given of the results of rocket observations carried out by NASA during the November, 1960, events.

18006

INVESTIGATION OF TECHNIQUES FOR 1000 F HYDRAULIC SYSTEMS
Republic Aviation Corp., Farmingdale, Long Island, N. Y.,
ASD-TDR-62-674, Sept., 1962, Tech. Doc. Rpt., June 1,
1960 - July 1, 1962, AF 33(616)-7454, 212 pp
Avail: ASTIA

This report covers the design, fabrication, and testing of components to be used in a hydraulic system where significant portions of the system operate at a fluid temperature of 1000 F in an ambient temperature of 1200 F, and the testing of a system combining these components at temperatures up to 1000 F. The characteristics of the mixed polyphenyl ether fluid for system use have been determined. The effect of gamma irradiation, total dose 1.7×10^{10} ergs g⁻¹ (C), at temperatures from 400 - 800 F on the viscosity of mixed phenoxyphenyl ether is reported. The testing and evaluation of static and dynamic seals for various components under varying degrees of temperature and pressure are included. Based on the successful results of the investigations and experiments accomplished under the contract, it is concluded that the design and production of a hydraulic system to operate reliably at fluid temperatures up to 1000 F is thoroughly feasible. However, it is recommended that further investigations be carried out in the following subjects: fluid control, pump endurance, servo valve selection, actuator design, reservoir design, modularization, control loop compensation, and additional components not investigated under the scope of this contract. Such investigations will amplify the results already obtained to enable the development of more comprehensive and varied systems.

18007

DESIGN CRITERIA FOR 1000 F HYDRAULIC SYSTEM
Republic Aviation Corp., Farmingdale, Long Island, N. Y.,
ASD-TDR-62-675, Sept., 1962, Tech. Doc. Rpt., AF 33(616)-
7454, 70 pp
Avail: ASTIA

This report covers criteria to be used in the design and fabrication of a hydraulic system and its components where significant portions of the system operate at a fluid temperature of 1000 F in an ambient temperature of 1200 F. The characteristics of the mixed polyphenyl ether fluid which must be considered in system and component design are stated, and the characteristics of the major materials used in the fabrication of the components are also discussed. The meta polyphenyl ethers have withstood doses of 10^{11} ergs/gram at 800 F and at 600 F. The fluid exhibited only a 50 per cent increase in viscosity after a 5×10^{11} erg/gram dose.

18008

E. H. Vestine
SPACE GEOMAGNETISM, RADIATION BELTS, AND AURORAL ZONES
Rand Corp., Santa Monica, Calif., RM 3144-PR, July, 1962,
Memo, AF 49(638)-700, 33 pp

A cursory non-critical review of the state of our knowledge of the geomagnetic field in space and of energetic charged particles trapped or guided by this field is presented. The unshielded dosages during a great solar event on a few days per decade exceed limits of human safety. Modest shielding of somewhat less than 1 gm/cm² will not remove the hazards. The chance is probably only one in several thousand that this will not suffice to preserve life on any given day. Transient accelerations of trapped particles result in atmospheric effects such as the aurora, and the polar electrojets, but the cause of these accelerative actions is quite obscure.

18009

R. D. Brown, R. A. Burton, and P. M. Ku
RESEARCH ON HIGH-TEMPERATURE BEARINGS
Southwest Research Institute, San Antonio, Tex., ASD-TR-
61-705, Aug., 1962, Tech. Rpt., March 10, 1960 - March,
1962, AF 33(616)-7209, 71 pp
Avail: ASTIA, OTS

This report describes the evaluation work performed on oscillating bearings of both plain journal and self-aligning types. The bearing substrate materials included cermet LT-1B and LT-2 and alloys F-48 and Rene 41. Lubricants receiving extensive evaluation were a clad silver-palladium alloy, molybdenum disulfide used in cavities, and bonded molybdenum disulfide. Results include those from friction and wear evaluations, radial load capacity tests on plain journal bearings, and axial and radial load capacity tests on self-aligning bearings. The bearing specimens had a nominal diameter of 1/2 inch. The friction and wear tests were made at an oscillating frequency of 31 cpm, at temperatures generally ranging from -90 to 1750 F, and at pressures generally ranging from 10^{-6} to 10^{-5} mm Hg. The projected bearing load was in the range of 4,400 to 12,000 psi.

18010

H. C. Sosnovosky
RADIATION EFFECTS ON SEMICONDUCTOR CATALYSTS
Illinois Institute of Technology, Armour Research
Foundation, Chicago, Ill., ASD-TDR-62-233, Oct., 1962,
Tech. Doc. Rpt., Jan. 1, 1961 - Jan. 31, 1962,
AF 33(616)-7740, 33 pp
Avail: ASTIA, OTS

The effect of ion bombardment on carrier lifetime, photoconductivity, and surface structure of germanium (111) crystals was investigated after bombardment at voltages between 10 and 2000 v. It was found that the lifetime decreased significantly at bombarding voltages above 80 v and that the number of defects in the surface region increased simultaneously by several orders of magnitudes. These defects are most likely dislocations and vacancy clusters. Less stable defects were introduced at very low bombarding voltages but these too were found to affect the electrical properties of the bombarded surfaces appreciably. Preliminary results of the effect of adsorbed gases on the properties of ion bombarded surfaces, and the effect of neutron bombardment on the catalytic exchange of hydrogen with deuterium on etched surfaces are included. Samples of germanium, hydrogen, and deuterium but no germanium, and both germanium and hydrogen-deuterium mixtures were given a total dosage of 10^{13} nvt. It was found that the radioactivity was of such a low level that no safeguards in handling were needed. The tubes were opened after 1 week and the contents analyzed by mass spectroscopy.

18011

F. R. Standerfer, H. J. Snyder, H. T. Watanabe,
L. G. Carpenter, R. I. Miller, and R. L. Pearson
HYDRAZINE PROCESS DEVELOPMENT
Aerojet-General Nucleonics, Azusa, Calif., ASD-TR-7-840A
(VII), Interim Tech. Engineering Rpt., Aug. - Oct.
1962, AF 33(600)-42996, 214 pp

This sixth quarterly progress report discusses fission fragment distribution studies, colloidal UO_2 preparation, improvements in uranium and hydrazine analytical techniques, in-reactor loop design modifications, fission fragment deposition measurements for a variety of sources, correlation of experimental heat transfer data, and a parametric reactor systems analysis. Distribution studies performed on the fission products of BMI slurry irradiations show that virtually all of the I^{131} and about half of the Ru^{103} are found in the decanted liquid phase; remaining non-volatile activity is adsorbed on the fuel particle surface. Three methods were evolved for converting aqueous UO_2 sols to colloidal UO_2 dispersible in liquid NH_3 . Pump bearing lifetime was extended as the result of impeller shroud flange modifications. Specific area of enriched, particulate UO_2 increased from 0.6 to 2.0 m^2/grams during 0.06 per cent burnup in the BMI slurry irradiation. More accurate calibration of energy deposition shows GNF_3 to be 4 in the $\text{N}_2\text{-F}_2\text{-UF}_4$ irradiation.

18012

James A. Knight, Jr.

RADIATION CHEMISTRY OF ORGANIC SYSTEMS

Georgia Institute of Technology, Engineering Experiment

Station, Atlanta, Georgia, Sept. 30, 1962, Prog. Rpt.

No. 4, Jan. 1 - Sept. 15, 1962, AT (40-1)-2490, 32 pp

Radiolysis products of C_8 and greater carbon content from the X-irradiation of 2,2,4-trimethylpentane and the radiolysis products from the X-irradiation of 2,2,4,6,6-pentamethylheptane are reported. Irradiation studies of 2,2,4-trimethylpentane with the 12 kilocurie Cs-137 source are well underway, and the results will be reported subsequently. Irradiation studies of 2,2,4,4-tetramethylpentane will be initiated in the near future.

18013

George R. Smolak, Richard H. Knoll, and Lewis E. Wallner

ANALYSIS OF THERMAL-PROTECTION SYSTEMS FOR SPACE-VEHICLE

CRYOGENIC-PROPELLANT TANKS

NASA-Lewis Research Center, Cleveland, O., NASA-TR-R-130,

1962, Tech. Rpt., 39 pp

Analytical techniques are presented that permit the calculation of heat-transfer rates with various thermal-protection systems for liquid-cryogenic-propellant tanks subjected to on-board, solar, and planetary heat fluxes. The thermal-protection systems considered include using closely spaced reflective surfaces (foils) and widely spaced reflective surfaces (shadow shields), insulation, arrangement of vehicle components, orientation with respect to radiant heating sources, and coatings for the control of solar absorptivity. The effectiveness of these thermal-protection systems in reducing propellant heating is shown both for ideal heat-transfer models and for a simplified hydrogen-oxygen terminal stage on a Mars mission. Shadow shields can be extremely effective in reducing the propellant heating due to both solar and on-board fluxes. However, low-altitude planet orbits can result in high propellant heating rates due to planetary radiation reflected from the shields. For low-altitude orbits of more than a few days, foils appear to be desirable for all cryogenic-tank surfaces. Foils are also effective in reducing the on-board heating. A choice of shadow shields or foils cannot be made until a particular vehicle and a particular mission are chosen. The thermal conductivity of insulation materials would have to be lower by about two orders of magnitude with no increase in density before insulation could compete with reflective surfaces for use in long-duration thermal protection of cryogenic tanks in space.

18014

Norman M. Wiederhorn and Jay H. Vreeland
THE THERMAL AND IONIZING RADIATION ASPECTS OF THE
STORAGE OF SELF-HEATING LIQUID PROPELLANTS IN SPACE
Arthur D. Little, Inc., Cambridge, Mass., TR-63270-05-02,
Sept., 1962, Tech. Rpt., NAS5-664, 57 pp

The concepts of the growth of the hot spots in self-heating materials have been extended and applied to the behavior of energetic propellants when exposed to ionizing radiation. As a result of this first-order treatment, it would appear that the size of the hot spot is so small that relatively high temperatures are involved (greater than 500 to 1000 C). In order that ionizing radiation lead to a self-sustaining reaction within a liquid propellant tank multiple simultaneous ionizations must occur within a small volume element. It would appear that in order to set off a material with two simultaneous events within a critical volume frequency factors in excess of 10^{16} inverse seconds are required. Based upon this it may be concluded that ionizing radiation in space poses no hazard to the storage of energetic monopropellants.

18015

NASA SPACE ENVIRONMENT TEST CHAMBER AND SOLAR RADIATION
SIMULATOR
University of Rochester, College of Engineering, Rochester,
N. Y., Oct. 20, 1961, Final Rpt., NAS w-181, 40 pp
Avail: NASA, N 62-10769

This report is concerned with the work undertaken to gather data on lamps which might be suitable sources of light for use in a solar simulator. It was decided to test a group of 2.5 kilowatt short-arc DC design mercury xenon lamps. The use of enclosed lamps rather than carbon arcs had by this time seemed desirable because of the very discouraging experiences of people who had tried to operate a small number of high-power carbon arcs for a reasonably long period of time. Certainly, while the carbon arc much more nearly matches the solar spectrum than any other single light source, it seemed clear that operating difficulties more than overcame this advantage.

18016

Trutz Foelsche
CURRENT ESTIMATES OF RADIATION DOSES IN SPACE
NASA-Langley Research Center, Hampton, Va., NASA-TN-D-1267,
July, 1962, Tech. Note, 51 pp
Avail: NASA, N 62-12380

This survey embraces the Van Allen belt radiations, galactic cosmic radiations, and solar cosmic radiations associated with solar flares. In the light of the current data the radiation problem is analyzed in terms of shielding requirements to keep exposure down to "tolerable" limits in manned space flights. The estimates are preliminary, especially in the cases of chance encounter with flare protons, since the available data are incomplete and only allow calculations of upper and lower limits of physical doses. Also the contribution of certain primaries and secondaries to the biological effect is not finally known.

18017

Louis F. Vosteen
ENVIRONMENTAL PROBLEMS OF SPACE FLIGHT STRUCTURES
NASA-Langley Research Center, Hampton, Va., NASA-TN-D-1474,
Oct., 1962, Tech. Note, 34 pp
Avail: NASA

This report summarizes the present state of knowledge of the natural radiation environment of space and discusses the manner in which the environment may interact with space vehicles. The radiation damage to various materials and spacecraft components is indicated and the selection of materials best suited for use as radiation shields is discussed. The necessity for providing protection against biologically damaging radiation is shown to be of prime concern for manned vehicles.

18018

A. J. Masley and A. D. Goedeke, Douglas Aircraft Co., Inc.
SPACE RADIATION: ITS NATURE AND PROPERTIES
Aerospace Engineering, 21, (6), June, 1962, pp 21-31

This article summarizes the galactic cosmic radiation, presents some results of recent measurements in the Van Allen zones, and gives the results of a detailed analysis of several of the major solar cosmic-ray events.

18019

Richard E. Gardner, California Institute of Technology,
Jet Propulsion Lab., Pasadena, Calif.
EFFECTS OF IONIZING RADIATION ON SOLID ROCKET MOTOR
COMPONENTS
ARS Journal, 32, (7), July, 1962, pp 1050-1053

Mechanisms of radiation degradation and its effects on tensile properties of propellant binders are discussed qualitatively. Data from a program of irradiation of several propellants are presented. Properties of two of the propellants were changed significantly by doses of the order of 4×10^8 ergs $g^{-1}(C)$ gamma irradiation. A PBAA ammonium perchlorate-aluminum propellant, an aluminized double-base propellant, and a polyurethane-ammonium perchlorate-aluminum propellant were selected for preliminary irradiation tests. The effect of radiation on the PBAA propellant was significantly less than the effect on the other propellants, in both burning rate and mechanical properties. In the double-base and polyurethane propellants, ultimate tensile strength drops rapidly for doses greater than 4×10^8 ergs $g^{-1}(C)$. Strain at maximum stress, secant modulus, and ultimate elongation also changed radically in this range.

18020

Richard J. Weber, NASA Lewis Research Center, Cleveland, O.
INFLUENCE OF METEOROID HAZARDS ON SELECTION OF SPACECRAFT
PROPELLANTS
ARS Journal, 32, (7), July, 1962, pp 1105-1106

It is ordinarily desirable to employ propellants with the highest specific impulse because this results in the smallest propellant-to-gross weight fraction. However, it is also desirable to employ propellants with high density since this tends to reduce the tank weight for any given propellant fraction. Two exposure

times have been studied: 10 days, representative of a lunar mission, and 500 days, representative of an interplanetary mission. The required stage gross weights for the two times are shown as functions of both bulk density and specific impulse. From these data it is possible to tell when it is beneficial to sacrifice specific impulse for the sake of higher density. Break-even curves are given to tell at a glance whether a particular propellant will be an improvement over O_2-H_2 .

18021

Y. Toi, D. B. Peterson, and Milton Burton, University
of Notre Dame, Notre Dame, Ind.
EFFECT OF DENSITY IN RADIOLYSIS OF AMMONIA
Radiation Research, 17, (3), Sept., 1962, pp 399-407

A stainless-steel autoclave with a volume of 10.03 cc served as a cell for irradiation in a Cobalt 60 γ -ray source of approximately 1200 curies. A study of the effect of density on the radiolysis of ammonia at 137 C reveals sharp decreases in $G(H_2)$ and $G(N_2)$ in the density region ~ 0.05 to 0.15 gm cc^{-1} . At densities less than $\sim 0.05 \text{ gm cc}^{-1}$, $G(H_2) = 6.2$, and $G(N_2) = 2.0$; at densities exceeding 0.15 gm cc^{-1} , $G(H_2)$ and $G(N_2)$ are about 1.5 and 0.4, respectively. It is notable that the G values begin to level off at densities well below the critical density of 0.235 gm cc^{-1} .

18022

P. G. Lucasson and R. M. Walker, General Electric
Research Lab., Schenectady, N. Y.
PRODUCTION AND RECOVERY OF ELECTRON-INDUCED RADIATION
DAMAGE IN A NUMBER OF METALS
Physical Review, 127, (2), July 15, 1962, pp 485-488

The changes in residual electrical resistance produced by bombardment with high-energy electrons were measured for a number of metals as a function of electron energy in the range from 0.5 to 1.4 Mev. The irradiations were performed at $\leq 20 \text{ K}$, and recovery measurements were made up to 300 K. The production curves were analyzed using simple displacement theory and the following values were found for the average threshold energies: Al, 32 ev; Au, > 40 ev; Ag, 28 ev; Cu, 22 ev; Fe, 24 ev; Mo, 37 ev; Ni, 24 ev; Ti 29 ev; and W, > 35 ev. Approximate values for the resistivities of Frenkel pairs (in units of $\mu \Omega \text{ cm per atmosphere}$) were also obtained as follows: Al, 3.4; Ag, 1.4; Cu, 1.3; Fe, 12.5; Mo, 4.5; Ni, 3.2; and Ti, 42. In the case of Al it was necessary to take secondary defect production into account and a number of representative theoretical curves, based on different assumptions concerning the process of secondary defect production are included. The behavior of Zn was anomalous in that the added resistivity was not a linear function of electron dose at 20 K.

18023

C. R. Cupp, International Nickel Co. of Canada Ltd.
THE EFFECT OF NEUTRON IRRADIATION ON THE MECHANICAL
PROPERTIES OF ZIRCONIUM-25 PER CENT NIOBIUM ALLOY
Journal of Nuclear Materials, 6, (3), Aug., 1962,
pp 241-255

This paper describes the effects of some heat treatments on the hardness of Zr-2.5 wt per cent Nb, and shows the effects of neutron irradiation at 50 C and at 250 C on its tensile and impact properties. One group of tensile specimens and impact bars was irradiated in air at 50 C to a calculated integrated flux of 1.3

$\times 10^{20}$ n/cm² (> 500 ev) in a standard NRX fast neutron rod. A second group of samples was irradiated to a flux of 1.0×10^{20} n/cm² (> 500 ev) in a high-temperature fast neutron rod. Post-irradiation damage recovery data are also presented. It has been concluded that the alloy's mechanical properties both before and after irradiation are significantly better than those of the Zircalloys. The heat-treated Zr-Nb alloy appears to be metallurgically stable under irradiation.

18024

SPACE RACE SPAWNS NEW LUBES

Chemical Week, 90, (25), June 23, 1962, pp 57, 58, & 60

Six kinds of extreme-condition lubricants are discussed: conventional and advanced fluids cover most uses under 1000 F. Liquid metals are being tried as bearing lubricants at higher temperatures; gases can lubricate bearings under low loads at high speeds and temperatures (e.g., 65,000 rpm at 1500 F). Usefulness in vacuum is limited; thin films of lubricating pigments, bonded by organic or inorganic agents, are widely used under 500 F, are being tested up to 1500 F; plating with metals, alloys or compound systems is being tried for uses up to 2000 F. Also of interest: porous substrates containing dry lubricants; finely divided solid or liquid lubricants, entrained in a gas carrier, show good results in lubricating bearings up to 1200 F. Constant flow is needed; carriers and lubricating film-formers available from other portions of a system (e.g., air and jet fuel) can be used as a continuously renewable lubricant.

18025

A. MacLachlan and R. L. McCarthy, E. I. Du Pont de Nemours & Co., Wilmington, Del.

PULSE RADIOLYSIS OF AROMATIC COMPOUNDS

Journal of the American Chemical Society, 84, (13), July 5, 1962, pp 2519-2524

Pulsed radiolysis of benzene, chlorobenzene, bromobenzene, toluene, p-xylene, anisole and mesitylene has led to the observation of transient absorptions. Product analysis, spectroscopic data and kinetic analysis indicate that the transients produced are free radicals, having a conjugated structure, derived from addition of reactive radicals to the parent aromatic compound. Bimolecular rate constants for the radical-radical reaction are calculated, and the rate of addition of phenyl radicals to chlorobenzene is estimated. Pulsed radiolyses were performed using a Linear Electron Accelerator. The absorbed energy per pulse is approximately 5.4×10^{18} ev/ml.

18026

Richard F. Heine, Minnesota Mining and Manufacturing Co., St. Paul, Minn.

SOME EFFECTS OF IONIZING RADIATION ON FLUOROCARBON LIQUIDS

Journal of Physical Chemistry 66, (11), Nov., 1962, pp 2116-2118

The effects of γ -radiation to a total exposure of 5×10^{10} ergs g⁻¹(C) on three perfluorinated liquids, C₈F₁₈, c-C₈F₁₆O, and (C₄F₉)₃N were studied. Radiation-induced changes in physical properties and in structure were determined. The results show the stability of the fluorocarbons toward radiation to be greater than that of the analogous hydrocarbons.

18027

W. H. Colner, Hughes Aircraft Co., Culver City, Calif.
SPACE - A NEW ENVIRONMENT FOR MATERIALS
Materials, Research & Standards, 2, (8), Aug., 1962,
pp 656-60

The Hughes Aircraft Company's space simulation facility is described. Inorganic materials exposed to the space environment have been metals, primarily magnesium. Vapor-pressure data for zinc and cadmium dictate against their use in spacecraft. Similar data for magnesium show that at slightly elevated temperatures there is a small loss of weight. The advantages of using magnesium in spacecraft stimulated a series of experiments to determine the effect of vacuum on the sublimation of magnesium. The magnesium alloys tested withstood the hard vacuum until fairly elevated temperatures were reached. An aluminum contact under pressure was exposed to 5×10^{-9} mm Hg at temperatures up to 250 F. No signs of cold welding were detected. In another experiment a steel rod was allowed to remain in contact with a plate in vacuum. They were held at 2×10^{-9} mm Hg for 100 days with no evidence of cold welding. The separated contact surfaces were then heated to about 1650 F for 1-1/2 hr in the vacuum, during which time the pressure increased to 10^{-4} mm Hg and then dropped back to 10^{-7} mm Hg. Definite cold welding occurred.

18028

L. D. Jaffe and J. B. Rittenhouse, Jet Propulsion Lab.,
California Institute of Technology
HOW MATERIALS BEHAVE IN SPACE
Materials in Design Engineering, 56, (3), Sept., 1962,
pp 97-104

This is an up-to-date report on how materials behave when exposed to vacuum, ions and electrons, electromagnetic radiation and meteoroids. The sublimation of metals and semiconductors, the decomposition of polymers, and the evaporation of low vapor pressure oils in high vacuum are described.

18029

M. A. Artsishevskii and Ya. P. Selisskii, Institute of
Precision Alloys
THE EFFECT OF NEUTRON IRRADIATION ON THE ELECTRICAL AND
MAGNETIC PROPERTIES OF CERTAIN ORDERING ALLOYS
Physics of Metals and Metallography, 11, (1), Oct., 1961,
pp 22-29

An investigation has been made of the effect of neutron bombardment in integral fluxes of 5×10^{16} and 5.5×10^{17} n/cm² at 60 degrees and in an integral flux of 4×10^{18} n/cm² at 350 degrees followed by tempering, on the alloys Ni₃Fe, Ni₃Cr, Ni₃Mn, Fe₃Al, Mo Permalloy and 50N. It is demonstrated that the variation in electrical resistivity and magnetic properties due to the irradiation of these alloys is appropriate for the establishment of states of higher equilibrium. Irradiation at 60 degrees accelerates the processes of the approach to an equilibrium state, which takes place with the subsequent tempering.

18030

Frederick I. Ordway, III, Editor, NASA-George C. Marshall
Space Flight Center, Huntsville, Ala.
ADVANCES IN SPACE SCIENCE AND TECHNOLOGY VOLUME 4
Academic Press, New York and London, 1962, 422 pp

This book discusses the doppler effect of artificial satellites; the possibilities of the existence of extraterrestrial intelligence; the development of multiple staging in military and space carrier vehicles; spacecraft entry and landing in planetary atmospheres; development of manned artificial satellites and space stations; and the utilization of radioactive elements as energy sources for spacecraft propulsion.

18031

C. R. Cupp
THE EFFECTS OF NEUTRON IRRADIATION ON PRECIPITATION-
HARDENING ALLOYS

International Nickel Co., Inc., Research Lab., Bayonne,
N. J., Tech. Paper 345, June 15, 1962, Paper presented
at the Fourth Pacific Area National Meeting of the
American Society for Testing and Materials, Los Angeles,
Calif., Oct 1-5, 1962, Paper No. 106, 43 pp

The effects of neutron irradiation on age-hardening alloys are of great importance in determining the usefulness of these alloys in reactors and are, in addition, of fundamental interest in determining the basic mechanisms of radiation effects. This paper describes the effects of irradiation on the mechanical, electrical, and magnetic properties and structural changes of copper-beryllium, nickel-beryllium, copper-iron, copper-cobalt, zirconium-niobium, certain nickel-base alloys and precipitation-hardenable steels. Work in progress includes further studies of aluminum-copper and nickel-titanium alloys.

18032

W. C. Young, F. J. Clauss, and S. P. Drake
LUBRICATION OF BALL BEARINGS FOR SPACE APPLICATIONS
Lockheed Missiles and Space Co., Palo Alto, Calif.,
Presented at the September, 1962 Meeting of the
ASTM, 22 pp

This paper reports on the evaluation of lubricants for use for space applications. In the first evaluation of materials in this environment bearings have been operated at 10^{-7} to 10^{-9} mm of mercury without replenishment of the lubricant. Tests are to be made where the lubricant will be evaluated while operating under vacuum and radiation. The following types of lubricants are being evaluated: oil lubricants, grease lubricants, molybdenum disulfide based lubricants, and special retainer materials. Lightly loaded ball bearings have been operated for over one year in a pressure of 10^{-8} mm of Hg using oil and grease lubricants. Over one-half year of successful operation has been achieved with special retainer materials. Tests with molybdenum disulfide films have given shorter life times and poor reproductibility of results. Tests are continuing to lengthen the lifetimes of these lubricants and to examine the effects of temperature, radiation and load.

18033

M. Grounes and H. P. Myers, AB Atomenergi, Studsvik,
Sweden

SWEDISH STUDIES ON IRRADIATION EFFECTS IN STRUCTURAL
MATERIALS

Paper presented at the Symposium on Radiation Effects
on Metals and Neutron Dosimetry, ASTM Fourth Pacific
Area National Meeting, Oct. 2-3, 1962, 11 pp

Tensile and impact specimens of the following steels have been irradiated: Steel 2103/R3, an aluminum-killed carbon-manganese steel; Steel SIS 142103, an aluminum-killed carbon-manganese steel; NO345, a quenched and tempered manganese-molybdenum low-alloy steel; Fortiweld, a normalized and tempered molybdenum-boron low-alloy steel; and OK 54 P, an un-alloyed basic weld metal. The first irradiations were made in the French graphite moderated reactor G1 in Marcoule. The irradiation temperature was 160 - 195 C and the neutron dose 2.5×10^{18} n/cm² (> 1 Mev). The changes in transition temperatures are reported for the metals.

18034

Monroe S. Wechsler

FUNDAMENTAL ASPECTS OF RADIATION EFFECTS ON DIFFUSION-
CONTROLLED REACTIONS IN ALLOYS

Oak Ridge National Lab., Oak Ridge, Tenn., Sept., 1962,
Paper No. 107, Presented at the Fourth Pacific Area
National Meeting of the American Society for Testing
and Materials, Los Angeles, Calif., Oct. 1-5, 1962, 70 pp

A review is given of the present concept of the vacancy mechanism of diffusion in metals and alloys and of the experimental evidence that supports it.

18035

J. F. Watson, J. L. Christian, General Dynamics/
Astronautics, San Diego, Calif., and J. W. Allen,
General Dynamics/Fort Worth, Fort Worth, Tex.

A STUDY OF THE EFFECTS OF NUCLEAR RADIATION ON HIGH-
STRENGTH MATERIALS AT THE BOILING POINT OF HYDROGEN
(20 K)

Paper, 40 pp

The problem of radiation damage occurring in structural materials at 20 K is of major importance in design studies of nuclear powered upper stage rockets. In this type of vehicle, large pressurized propellant tanks containing liquid hydrogen at 20 K are subjected to large doses of both neutron and gamma fluxes. Thus the structural materials experience a combined environment of cryogenic temperature and nuclear radiation. To study the nature of these effects, samples were exposed to an integrated fast neutron flux of about 2×10^{17} (E > .33 Mev) nvt while being soaked in liquid hydrogen. After the radiation exposure the samples were subjected to tensile tests while being held at 20 K without intervening warmup. The alloys studied were 301 and 310 stainless steels, 5 Al-2-1/2 Sn titanium (AlloAT), and 2014-T6 aluminum. The tensile tests performed gave yield strength, tensile strength, elongation, notched tensile strength and the tensile strength of simple heliarc butt welded joints.

18036

E. Landerman

SURVEILLANCE TESTS ON STRUCTURAL MATERIALS IN NUCLEAR
REACTORS

Westinghouse Atomic Power Division, Pittsburgh, Pa.,
Paper No. 117, Presented at the Fourth Pacific Area
National Meeting of the American Society for Testing
and Materials, Los Angeles, Calif., Oct. 1-5, 1962,
25 pp

The Yankee Atomic Electric Company surveillance program for the reactor vessel is described as to preirradiation testing of material, type of specimens, location of specimens, use of neutron detectors and correlation monitors, post-irradiation tests, and schedule of program.

18037

R. W. Nichols and D. R. Harries

BRITTLE FRACTURE AND IRRADIATION EFFECTS IN FERRITIC
PRESSURE VESSEL STEELS

U. K. Atomic Energy Authority, Reactor Materials Lab.,
Culcheth, & AERE, Harwell, Eng., Paper No. 114,
Presented at the Fourth Pacific Area National Meeting
of the American Society for Testing and Materials,
Los Angeles, Calif., Oct. 1-5, 1962, 50 pp

The effect of irradiation temperature in the range 85 to 300 C for a constant integrated neutron dose of 8.1×10^{17} n/cm² in the BEPO reactor on the changes in room temperature tensile properties and slow-bend transition temperatures of a normalised silicon killed carbon steel are shown. The increases in yield stress and transition temperature are independent of the irradiation temperature below 250 C but at higher temperatures annealing of the damage occurs due to annihilation of the point defects. The effects of irradiation temperature on embrittlement have also been investigated for various welded commercial pressure vessel steel plates whose thicknesses and analyses are given.

18038

F. C. Robertshaw, J. Moteff, F. D. Kingsbury, and
M. A. Pugacz

NEUTRON IRRADIATION EFFECTS IN A-286, HASTELLOY X AND
RENE' 41

General Electric, Nuclear Materials & Propulsion
Operation, Cincinnati, O., TM-62-9-9, Sept. 24, 1962,
Presented at West Coast 1962 ASTM Symposium on
Radiation Effects in Metals, Oct. 2-3, 1962, 55 pp

A-286, Hastelloy X, and Rene' 41 were irradiated in the Engineering Test Reactor at approximately 540 C and 650 C to fast neutron dosages of 4 to 11×10^{19} nvt ($E_n \geq 1$ Mev). Post-irradiation stress-rupture tests were conducted at 540 C and 650 C. The effect of reheat treatment following irradiation was investigated. The results indicate that the stress-rupture strengths of A 286 and Hastelloy X at 540 C and 650 C have been significantly reduced by irradiation. A similar effect was observed in Rene' 41 at 650 C. The A-286 alloy showed substantial reductions in rupture ductility, particularly at 650 C. A similar loss in ductility in one of two heats of Rene' 41 was observed at 650 C. The ductility of Hastelloy X, though affected, remained at relatively high levels.

18039

Norman E. Hinkle

THE EFFECT OF NEUTRON BOMBARDMENT OF THE STRESS RUPTURE
PROPERTIES OF SOME STRUCTURAL ALLOYS

Oak Ridge National Lab., Solid State Div., Oak Ridge, Tenn.,
Sept., 1962, Paper No. 122, Presented at the Fourth
Pacific Area National Meeting of the American Society
for Testing and Materials, Los Angeles, Calif., Oct. 1-5,
1962, 35 pp

The materials being investigated are Inconel alloy 600, type 304 stainless steel, zircaloy-2 and a columbium-1 per cent zirconium alloy. The rupture strength of Inconel alloy 600 at 1500 F is decreased as much as 25 per cent during irradiation. Smaller losses of rupture strength are observed for type 304 stainless steel at 1300 to 1500 F and the columbium alloy at 1800 F. No major change is observed for zircaloy-2 at 700 or 900 F. The neutron flux in the two ORR positions used for these experiments average about 5×10^{13} neutrons/cm²/sec (> 0.6 Mev).

18040

J.G.Y. Chow, S. B. McRickard and D. H. Gurinsky

THE MECHANICAL PROPERTIES OF IRRADIATED IRON AND IRON
ALLOYS

Brookhaven National Lab., Upton, N. Y., BNL-6249,
Paper No. 105, Presented at the Fourth Pacific Area
National Meeting of the American Society for Testing
and Materials, Los Angeles, Calif., Oct. 1-5, 1962,
54 pp

The effects of fast neutron irradiation on the yielding, plastic flow and fracture properties of pure iron; iron alloyed with carbon and iron alloyed with chromium were studied as part of an investigation of irradiation damage in b.c.c. metals. In addition, A212B and Mod HY80, were also analyzed. It was observed in the pure iron that yield stress is reduced to zero by a fast neutron irradiation of 2×10^{18} nvt. An exposure of 2×10^{18} nvt or greater produced a sharp ductile to brittle transition point with a shift of 85 K in pure iron.

18041

A. L. Lowe, Jr.

EFFECTS OF RADIATION ON TWO LOW-ALLOY STEELS AT ELEVATED
TEMPERATURES

Babcock & Wilcox Co., Lynchburg, Va., Paper No. 115,
Presented at the Fourth Pacific Area National Meeting
of the American Society for Testing and Materials, Los
Angeles, Calif., Oct. 1-5, 1962, AT (30-1) 1940, 29 pp

The effects of temperature during irradiation on the tensile and impact properties of two low-alloy steels were studied. Tensile and impact specimens of 1-1/4 per cent Cr - 1/2 per cent Mo and 2-1/4 per cent Cr and 1 per cent Mo steels were irradiated in a range of 2.8×10^{18} to 2.0×10^{20} nvt (greater than 1 Mev) and over a temperature range from room temperature to 1700 F. Results from post-irradiation examinations conducted at room temperature indicate that the radiation effect on tensile properties are reduced at irradiation temperatures above 725 F and at irradiation temperatures between 900 - 1100 F there is no apparent irradiation damage. For specimens irradiated above approximately

1100 F the tensile and yield strength increased again and strength levels equal to the unirradiated values were not observed until the steel was heated above the A_3 (1630 F). The second increase in tensile and yield strength may be associated with microstructural changes.

18042

Vincent L. Donlan, Aeronautical Systems Div.
THE PROTON HAZARD IN SPACE-BIOLOGICAL DOSES
SAMPE Symposium, pre-print, May, 1962, 13 pp

The flux levels and proton energies of Van Allen belt and solar flare protons are sufficient to present a major biological hazard in space flight. In this paper, biological and tissue removal doses are presented and compared for the Van Allen belt and for the solar flare of May 12, 1959. The bulk of the biological dose is shown to be contributed by low energy protons. Shield weights for minimal protection against the proton hazard are computed and found to be on the order of 10,000 pounds per man.

18043

R. E. Mauri
PERFORMANCE OF LUBRICANTS AND THERMAL CONTROL MATERIALS
UNDER SIMULATED SPACE CONDITIONS
Lockheed Missiles & Space Co., Palo Alto, Calif., SAMPE
Symposium, pre-print, AF 04(647)-787, 25 pp

Experimental details and results on the effect of high vacuum and operating conditions on oils, greases, and dry-film lubricants for bearings are presented. Also discussed are applications of thermal control materials and results of environmental testing of solar reflectors such as white paints in the presence of intense ultraviolet radiation in vacuum.

18044

James E. Keith and Anthony L. Turkevich, Enrico Fermi
Institute for Nuclear Studies, and Dept. of Chemistry,
University of Chicago, Chicago, Ill.
RADIOACTIVITY INDUCED IN DISCOVERER 17 BY SOLAR-FLARE
PROTONS
Journal of Geophysical Research, 67, (12), Nov., 1962,
pp 4525-4532

A sheet of lead 7 mm thick, part of the recovered United States satellite Discoverer 17, has been examined for evidence of bombardment by solar protons while the satellite was in a polar orbit (November 12-14, 1960) during a class 3⁺ solar flare. Bismuth 205 has been isolated by radiochemical techniques from 100-gram quantities of the lead and counted by X-ray gamma coincidence scintillation spectroscopy. The radioactivity at the time of recovery was about 1000 dpm of Bi^{205} per kilogram of lead. Known cross sections for the nuclear reactions involved lead to an integrated omnidirectional flux above 57 Mev of 5.7×10^8 protons/cm². The energy spectrum of the protons is deduced from the variation in depth of the Bi^{205} radioactivity.

18045

W.G.V. Rosser, B. J. O'Brien, J. A. Van Allen, L. A. Frank, and C. D. Laughlin, State University of Iowa, Iowa City, Iowa
ELECTRONS IN THE EARTH'S OUTER RADIATION ZONE
Journal of Geophysical Research, 67, (12), Nov., 1962, pp 4533-4542

Preliminary results from Explorer 12 during August and September, 1961 show that near the geomagnetic equatorial plane the omnidirectional intensity of 40-55 kev electrons is usually constant to a factor of 2 or 3 between radial distances of 25,000 and about 55,000 km; then it diminishes rapidly near the termination of the earth's magnetic field, which is generally at about 65,000 km. Typical midzone values for electrons between 40 and 55 kev are 10^6 to 10^7 electrons $(\text{cm}^2 \text{ sec})^{-1}$. The intensity of 80- to 100-kev electrons shows a similar radial dependence and a similar absolute value, but diminishes toward zero at a lesser radial distance. The general structure of the outer zone as measured with a 302 Geiger tube by the staff members of this laboratory and other laboratories during the past four years is confirmed but is now shown to correspond to electrons of energy greater than 1.6 Mev in intensities of 10^3 to 10^5 $(\text{cm}^2 \text{ sec})^{-1}$ in the heart of the zone. Important spectral changes accompany geomagnetic storms.

18046

G. F. Pieper, A. J. Zmuda, C. O. Bostrom, The Johns Hopkins University, Silver Spring, Md., and B. J. O'Brien, State University of Iowa, Iowa City, Iowa
SOLAR PROTONS AND MAGNETIC STORMS IN JULY 1961
Journal of Geophysical Research, 67, (13), Dec., 1962, pp 4959-4981

The State University of Iowa's satellite Injun 1 was launched at 0422 UT on June 29, 1961, and is in an orbit of 67 degrees inclination with apogee 998 km and perigee 881 km. Among the Injun instruments are silicon p-n junction detectors sensitive to protons with energy between 1 and 15 Mev, and a Geiger counter sensitive to protons of energy above 40 Mev. The proton intensity varied widely with a maximum unidirection flux of 33,000 particles/ $\text{cm}^2 \text{ sec ster}$ for 1- to 15-Mev protons occurring during the storm of 1115 UT, July 13, and a maximum omnidirectional flux of 900 particles/ $\text{cm}^2 \text{ sec}$ for protons of energy above 40 Mev in the storm of 1121 UT July 18. In general, the energy spectrum varied from storm to storm and within a single storm.

18047

D. A. Bryant, T. L. Cline, U. D. Desai, and F. B. McDonald, NASA-Goddard Space Flight Center, Greenbelt, Md.
EXPLORER 12 OBSERVATIONS OF SOLAR COSMIC RAYS AND
ENERGETIC STORM PARTICLES AFTER THE SOLAR FLARE OF
SEPTEMBER 28, 1961
Journal of Geophysical Research, 67, (13), Dec., 1962, pp 4983-5000

A full description of the cosmic ray experiment on Explorer 12 is given and cosmic ray measurements made during the solar event of September 28, 1961, are reported and discussed. Galactic cosmic ray measurements are also reported. A few hours before the class 3 flare of September 28, two short counting rate

increases were observed and are interpreted as electron bursts. The anisotropy of the medium- and low-energy solar protons early in the event and their intensity throughout the event are described. It is found that the history of the intensity of the solar protons is consistent, once isotropy is established, with their having diffused through interplanetary space with an effective mean free path of 0.04 AU. This result is discussed and is shown to be not obviously in disagreement with the generally accepted views regarding the configuration of the interplanetary magnetic field. Two days after the flare, and beginning just before the sudden commencement of a magnetic storm, there was a large increase in the intensity of protons between 2 and 15 Mev, the lower energy limit being determined by the sensitivity of the detectors. As most of these particles, which we have called "energetic storm particles," arrived after the sudden commencement occurred, we suggest that they were solar protons trapped within the plasma cloud which caused the magnetic storm. The outline of a possible trapping mechanism is given. Explorer 12 measurements of the Forbush decrease of September 30, 1961, are compared with neutron monitor measurements at Deep River. The decrease is larger at Explorer 12 by a factor of 1.7 ± 0.3 .

18048

R. A. Hoffman, L. R. Davis, and J. M. Williamson,
NASA-Goddard Space Flight Center, Greenbelt, Md.
PROTONS OF 0.1 TO 5 MEV AND ELECTRONS OF 20 KEV AT
12 EARTH RADI DURING SUDDEN COMMENCEMENT ON
SEPTEMBER 30, 1961
Journal of Geophysical Research, 67, (13), Dec., 1962,
pp 5001-5005

During the period around the sudden commencement of the September 30, 1961, magnetic storm, the ion-electron detector aboard Explorer 12 observed fluxes of low-energy protons and electrons while the satellite was at 12 earth radii and free of the magnetosphere. Whereas the proton intensities initiated an increase about 25 minutes before the sudden commencement, a sudden jump of the omnidirectional intensity occurred eight minutes before the sudden commencement. The maximum flux of about 2×10^5 protons/cm² sec ster above 140 kev was attained a half hour after the sudden commencement. The detection efficiency for electrons places an upper limit of 2×10^5 electrons/cm² sec ster for the rest of the storm.

18049

Michel Bader, NASA-Ames Research Center, Moffett Field,
Calif.
PRELIMINARY EXPLORER 12 DATA ON PROTONS BELOW 20 KEV
Journal of Geophysical Research, 67, (13), Dec., 1962,
pp 5007-5011

The data for the period September 27 through October 4, 1961, were examined in some detail because of the concurrent solar and geomagnetic activities. The proton fluxes in the directions sampled were generally below the threshold of detectability of the instrument. This is an extremely significant result in view of the fact that the magnetometer records clearly demonstrate that the apogee of the satellite was beyond the normal, compressed geomagnetic field.

18050

P. F. Gustafson, S. S. Brar, and M. A. Kerrigan,
Argonne National Lab., Argonne, Ill.
AIRBORNE RADIOACTIVITY DUE TO NUCLEAR WEAPONS TESTS
Journal of Geophysical Research, 67, (12), Nov., 1962,
pp 4641-4651

Samples of surface air collected at Argonne National Laboratory since early 1952 have been analyzed for specific fission products by NaI scintillation spectrometry. The ^{181}W and ^{102}Rh produced in the Hardtack series (1958) have been used to assign nuclear debris to the low- and high-altitude phases of this series, respectively. Activity ratios between appropriate radionuclides have been used to determine the portion of total debris arising from the Soviet October, 1958 series. The differences in mean stratospheric residence time as a function of latitude and altitude of injection, as deduced from these data, are discussed in detail.

18051

J. B. Cladis and M. Walt, Lockheed Missiles and Space
Co., Palo Alto, Calif.
BEHAVIOR OF GEOMAGNETICALLY TRAPPED ELECTRONS INJECTED
BY HIGH-ALTITUDE NUCLEAR DETONATIONS
Journal of Geophysical Research, 67, (13), Dec., 1962,
pp 5035-5054

This report describes recent investigations of the data obtained by the Jason sounding rockets during the Argus nuclear weapon tests. These instrumented rockets contained radiation detectors and observed electrons that were injected into the geomagnetic field by the decaying fission fragments from the second Argus explosion. The investigations reported here yielded (1) the orientations of the detectors with respect to a plane perpendicular to local magnetic lines of force, (2) the calibration of the detectors in a planar flux of electrons as functions of electron energy and orientation of the detectors with respect to the electron plane, and (3) a re-evaluation of the Jason data based on items (1) and (2) and on recent data on characteristics of the natural radiation. The conclusions verified the results of the initial analysis regarding the location, width, and stability of the electron 'shell' produced by the Argus 2 detonation, as well as the presence of a less intense electron flux in wide regions (wings) away from the shell. In contradiction to the earlier analysis, it was found here that the electron spectrum was much more in agreement with the fission spectrum. Within the accuracy of the data, the observed spectrum was found to be independent of the spatial locations of the rockets or of the passage of time.

18052

C. E. Feltner
ON THE MECHANICAL BEHAVIOR AND FRACTURE MORPHOLOGY OF
EPOXY RESIN
University of Illinois, Dept. of Theoretical and Applied
Mechanics, Urbana, Ill., TAM-224, Aug., 1962,
Nonr-2947(02)(x), 24 pp

An investigation has been made of the relation between the mechanical behavior and the characteristic patterns of the fracture surface markings of an epoxy resin. A radiation dose of 10^{14} nvt has no measurable effect on the mechanical behavior and fracture morphology of epoxy resin.

18053

W. C. Sears

INFRARED SPECTRA OF PLASTICS AND ELASTOMERS AFTER
NUCLEAR IRRADIATION

University of Georgia, Dept. of Physics and Astronomy,
Athens, Ga., Research Rpt., 1962, AT-(40-1)-2418,
25 pp

A gamma ray dose of 5.6×10^9 rads formed unsaturated groups of type $R_1R_2C=CHR_3$ in polyvinyl carbazole. Polyethylene DYNH was found to form fewer ring links than Marlex 50 at the same dose. The trans-vinylene concentrations in DYNH were found to be 0.056×10^{-4} , 0.70×10^{-4} , and 2.5×10^{-4} moles/g after gamma ray doses of 0, 2.67×10^{21} , and 2.44×10^{21} ev/g. Irradiation of polychlorotrifluoroethylene produced double bonds of types $RCF=CF_2$ and $R_1CF=CFR_2$. Evidence for loss of chlorine and specific fluorine atoms was cited. Irradiation of polypropylene to doses of 2×10^9 and 1.6×10^9 rads appears to form some vinyl groups as well as vinylidene unsaturation. Several new bands were observed in the spectra of irradiated polypropylene. The bands in polyacrylonitrile after a dose of 1.49×10^9 rads were not as well resolved as after a dose of 1.05×10^9 rads. Apparently, the multiplicity of different molecular compounds formed during irradiation contributed overlapping bands, which tend to obscure all but the most intense new bands. Polyvinyl acetate revealed only minor changes in its infrared spectrum after a dose of 1.85×10^8 rads in vacuum.

18054

George Odian and Bruce S. Bernstein

A STUDY OF THE MECHANISM OF RADIATION-INDUCED GELATION
IN MONOMER-POLYMER MIXTURES

Radiation Applications Inc, Long Island City, N.Y.,
RAI-311, Oct. 31, 1962, May 1, 1961 - Oct. 31, 1962,
AT(30-1)-2816, 68 pp
Avail: OTS

The use of polyfunctional monomers greatly increases the efficiency and economy of the crosslinking process relative to the straight radiation crosslinking technique. For example, the dose required to produce a 50 per cent gel content in polyethylene was found to be approximately 1.5 Mrad for the monomer crosslinking technique using allyl methacrylate as compared to 11 Mrads for the straight radiation technique. Similar results were obtained with polypropylene, polyisobutylene and cellulose acetate. The properties of the various monomer-crosslinked materials showed substantial improvements. The high temperature stability of polyethylene and polypropylene both in air and in vacuum is greatly increased via the monomer-crosslinking technique. By the monomer-crosslinking technique, the incipient gelation dose for polyethylene, polypropylene and polyisobutylene has been found to be 0.05 Mrad or less. The efficiency improvement, as measured in this manner, is a factor of about 20 for polyethylene, about 1000 for polypropylene and "infinity" for polyisobutylene. In the latter instance, the nature of the normal reaction has been reversed; the same applies to cellulose acetate.

18055

T. R. Paxton and E. E. Mooney

RADIATION-RESISTANT POLYMERS

B. F. Goodrich Co., Brecksville, Ohio, 18th Monthly

Summary Rpt., July 1962, AF33(616)-7491, 7 pp

The radiation induced changes of a group of acrylates with substituents in the 2-position do not follow the normal pattern of gel formation or chain scission. In acrylate polymers the crosslink density increases uniformly with radiation dose and more or less reaches equilibrium at high doses, depending upon the amount of concurrent scission. In methacrylate polymers the number of molecules increases uniformly with radiation dose. The antirad effectiveness of Flexzone-3C (N-phenyl-N'-isopropyl-p-phenylene diamine), Sustane (butyrate hydroxyanisole), and Solux (N-p-hydroxyphenyl morpholine) in a Hycar rubber compound was studied. Compression set at 5.23×10^9 ergs/gram (C) and the radiation exposure dose required for 50 per cent compression set were measured. These three additives afford protection to Hycar 1001 in each case, Flexzone-3C being the best. However, it appears that 5 phr is approximately the optimum level for these antirads under these conditions.

18056

W. L. Weiss and E. M. Whatley

EFFECTS OF LONG TERM VACUUM ON COMMERCIAL SILICON

RADIATION DETECTORS

Oak Ridge Technical Enterprises Corp., Oak Ridge, Tenn.,

ARL 62-416, Aug., 1962, Final Tech. Doc. Rpt.,

Oct. 1, 1961 - May 24, 1962, AF 33(616)-8397, 137 pp

Avail: ASTIA, OTS

The data presented are a graphical representation describing the effects of long term vacuum ($\sim 10^{-6}$ mm Hg for 6 months) on commercially available silicon radiation detectors of two types: surface barrier, which are manufactured from n-type single crystal silicon and diffused junction, which are manufactured from p-type single crystal silicon. Data include measurements of alpha resolution, dead layer or window thickness, RMS noise voltage, reverse leakage current and pulse height stability at rated voltage. In addition, the report includes a summary of radiation damage on semiconductor materials and devices.

18057

T. R. Paxton and E. E. Mooney

RADIATION-RESISTANT POLYMERS

B. F. Goodrich Co., Brecksville, Ohio, 20th Monthly

Summary Rpt., Sept., 1962, AF 33(616)-7491, 10 pp

The radiation-induced crosslinking rates are being measured for the series of phenyl acrylate-butyl acrylate copolymers and α -naphthyl acrylate-butyl acrylate copolymers. These elastomeric copolymers contain a small proportion of vinylbenzyl chloride as a termonomer to provide active curing sites. Preliminary results show that the copolymers are crosslinking much faster than was expected. It may well be that the vinylbenzyl chloride is quite susceptible to radiation-induced crosslinking. Compression set

data for Hycar 1072 and Hycar 1000 x 145 at 5.23×10^9 ergs/g(C) are shown. Hycar 1000 x 145 shows somewhat better radiation resistance than Hycar 1072. In the presence of the antirad Flexzone 6H the former rubber shows considerably improved resistance to radiation-induced compression set.

18058

P. A. Lockwood

INVESTIGATIONS OF RADIOACTIVE FUEL-BEARING GLASSES

Owens-Corning Fiberglas Corp., Granville, O., NYO-9736,

June 30, 1962, AEC Research and Development Rpt.,

April 1, 1961 - March 31, 1962, AT-(30-1) 2489,

43 pp

A series of high urania-content glasses were fiberized and examined for high temperature strength properties. One glass, RX360 containing 60 per cent U_3O_8 by weight, had better high temperature tensile properties than any glass previously reported. It was observed that many of the glasses studied separated into immiscible phases and that the fiberizable glass phase had lower U_3O_8 content than the base compositions. A physical analysis of crystal structures of the devitrification products from the nuclear fuel glasses indicated that most of the crystals consisted of uranium oxide in a reduced state.

18059

P. A. Lockwood

INVESTIGATIONS OF RADIOACTIVE FUEL-BEARING GLASSES

Owens-Corning Fiberglas Corp., Granville, O., NYO-9735,

July 31, 1961, AEC Research and Development Rpt.,

May 1, 1960 - March 31, 1961, AT-(30-1)-2489,

46 pp

A series of glass compositions containing uranium oxide were investigated to determine fiberizability and physical properties of resultant fibers. The basic properties to be determined were (1) the maximum U_3O_8 content in a fiberizable glass and (2) the maximum service temperature of the fibers. Glasses containing 60 weight per cent U_3O_8 were fiberizable; the fibers had strengths of 100,000 psi at 1600 F. Samples were prepared for experimentation on the utilization of fuel-bearing glasses in chemo-nuclear and power reactors.

18060

R. S. Barker

IRRADIATION ON GLASS YARNS

Pilkington Brothers Ltd., Lancashire, Eng., IT-95, Mod.,

Dec., 1961, 9 pp

The present work was undertaken to determine the change in tensile strength of glass yarns after reactor irradiation in fluxes of up to 10^{14} neutrons/cm²/sec to doses of 10^{12} , 10^{14} , 10^{16} , 10^{18} , 10^{19} , and 10^{20} nvt at temperatures up to 400 C, with the object of determining the suitability of glass fibre as electrical insulation in nuclear reactors. There was no melting of the glass or any undesirable effects from nuclear heating.

18061

Meyer Steinberg, P. Colombo, R. N. Chapman, and George Adler

RADIATION PROCESSING REPORT NO. 4 POLYMERIZATION OF
ETHYLENE BY COBALT-60 GAMMA RADIATION

Brookhaven National Lab., Upton, N.Y., BNL-740 (T-268),

July, 1962, 39 pp

Avail: OTS

The yield and rate of polymerization of ethylene in a Cobalt-60 gamma field was determined by a continuous pressure recording technique. The conditions under which the rate was measured varied in pressure from 680 atm to less than 68 atm, in temperature from -78 C to 40 C, and in intensity from 20,000 to 560,000 rad/hr. The experiments indicate that the effect of the presence of polymer on the polymerization rate is smaller than the effect of oxygen and ethylene pressure. The addition of argon acts as a diluent in decreasing the polymerization rate. The differential G values based on monomer alone, were determined, and attempts were made at expressing these values as a function of ethylene pressure and radiation intensity. The polymers produced consisted of fine white powder with properties dependent on pressure and irradiation conditions.

18064

Norman E. Wahl, Roy R. Lapp, and Frederick C. Haas

THE EFFECTS OF HIGH VACUUM AND ULTRAVIOLET RADIATION ON
NONMETALLIC MATERIALS

Cornell Aeronautical Lab., Inc., Buffalo, N.Y., WADD-TR-

60-125, Pt. II, June, 1962, Tech. Documentary Rpt.,

Part II, Feb. 1, 1960 - April 1, 1961, AF 33(616) 6267,

73 pp

Avail: ASTIA

This study was concerned with the behavior of nonmetallic materials exposed to simulated single and combined elements of space environment. The conditions simulated were those of atmospheric composition, pressure, temperature, and ultraviolet radiation. The loss in weight and strength of three types of structural plastic laminates after exposure to vacuum and ultraviolet radiation intensities from two to six times that experienced outside the earth's atmosphere were determined. Evaluation of the effect of vacuum ultraviolet on glass and plastic glazing materials indicated that the transmission of the glass was not affected. The transparent plastic materials yellowed, bubbled and become translucent but showed little chemical degradation of the polymer chains by infrared spectroscopy. A white polyurethane coating exposed to separate elements of heat, vacuum and ultraviolet radiation showed significant changes in weight, color and spectral absorptivity in the range of 0.38 to 2.0 microns. A method of determining the absorptivity and heat transfer characteristics of plastics while exposed to vacuum ultraviolet is described.

18065

E. G. Fritz and P. M. Johnson

TENSILE BEHAVIOR AND MOLECULAR CHARACTERISTICS OF
IRRADIATED ELASTOMERS

General Dynamics/Fort Worth, Nuclear Aerospace Research

Facility, Fort Worth, Tex., NARF-62-8T, MR-N-294,

July, 1962, AF 33(657)-7201, 43 pp

Avail: ASTIA

Stress-strain data on polyurethane and silicone elastomers that were irradiated in air at -65 F, 80 F, 260 F, and 350 F, were analyzed on the basis of the Mooney-Rivlin relationship. According to the molecular implications of this relationship, the total effective crosslinking density was calculated. The results indicate that, upon irradiation to doses on the order of 10^{10} ergs/gm(C), all Adiprene-L and most Disogrin specimens preponderantly degraded while all Genthane and General Tire Type-R specimens preponderantly crosslinked. A supplementary preliminary analysis of stress-strain data of silicone elastomers via this approach showed, with few exceptions, a radiation-induced increase in the total effective crosslinking density.

18066

E. G. Fritz and P. M. Johnson

ULTIMATE AND PSEUDO-EQUILIBRIUM TENSILE PROPERTIES OF
IRRADIATED ELASTOMERS

General Dynamics/Fort Worth, Nuclear Aerospace Research
Facility, Fort Worth, Tex., NARF-62-9T, MR-N-295,
Aug., 1962, AF-33(657)-7201, 43 pp
Avail: ASTIA

An analysis of experimental data is presented on the ultimate and pseudo-equilibrium stress-strain behavior of various commercially prepared vulcanizates that were irradiated in the Nuclear Aerospace Research Facility Ground Test Reactor. The study included the following types of vulcanizates: polyurethanes, silicones, natural rubber (NR), NR-SBR blend, and neoprene-NR blend. An initial attempt to fit these data to the empirically derived Charlesby stress-strain-dose relationship was unsuccessful.

18067

E. G. Fritz and P. M. Johnson

COMPRESSION-SET BEHAVIOR OF IRRADIATED ELASTOMERS

General Dynamics/Fort Worth, Nuclear Aerospace Research
Facility, Fort Worth, Tex., NARF-62-10T, MR-N-296,
Aug., 1962, AF-33(657)-7201, 25 pp
Avail: ASTIA

The effects of mixed-field reactor radiation and pure gamma rays on the compression-set behavior of three different vulcanizates: Viton A, Silicone LS-53, and Neoprene WRT are analyzed. It was found that the data conformed quite well to a skew logistic expression. The results of the analysis are discussed and compared with similar work carried out at the B. F. Goodrich Research Center.

18068

B. G. Achhammer

PHOTOLYSIS OF POLYMERS

U.S. Dept. of Commerce, National Bureau of Standards,
Washington, D.C., NBS-7171, June 14, 1961, Tech. Rpt.,
Dec. 1, 1960 - May 31, 1961, 8 pp
Avail: NBS

The current effort is to establish the mechanism of the photodegradation of poly(vinyl acetate) by ultraviolet irradiation in air and in vacuum. Chips of the poly(vinyl acetate) were also irradiated by Cobalt 60 gamma for a total dosage of 40 Mrads. All of the specimens produced a gel when placed in ethanol. This suggests that crosslinking occurred as a result of the combined treatment. Gaseous products collected during some of the exposures of poly(vinyl acetate) to ultraviolet radiant energy in vacuum, were analyzed by mass spectrometry.

18069

John P. Cahill and Hervey P. Gauvin, Air Force Cambridge Research Labs., and John C. Johnson, Technical Operations, Inc.

EFFECTIVE TRANSMISSION OF THERMAL RADIATION FROM NUCLEAR DETONATIONS IN REAL ATMOSPHERES

U.S. Air Force, Air Force Cambridge Research Labs., Bedford, Mass., AFCRL-62-456, April, 1962, Air Force Surveys in Geophysics No. 144, 80 pp

Avail: ASTIA, OTS

A study is made of the geographical factors influencing the transmission of thermal radiation from nuclear weapons through cloudless atmospheres. The primary influencing factors considered are the scattering and absorbing properties of the atmosphere, reflection from the underlying surface, the temperature-time characteristics of the source, and the source-detector geometry.

18070

L. A. Wall and R. E. Florin, NBS, Washington, D. C.,
GAMMA IRRADIATION OF FLUOROCARBON POLYMERS AND SMALL MOLECULES

Wright Patterson AFB, Aeronautical Research Lab., O.,
ARL-62-350, May, 1962, Final Tech. Rpt., AF-33(616)-60-4,
8 pp

Avail: ASTIA, OTS

Work upon the effects of gamma irradiation on fluorocarbon polymers and small molecules is summarized, including a list of publications. The subject matter includes physical properties (principally zero-strength-times and tensile strengths); volatile products; effects of oxygen and chlorine atmospheres; radiation chemistry of perfluoroheptane, hexafluorobenzene and mixtures; sensitizing or radiation--induced polymerization; and yields of radicals by electron spin resonance.

18071

George Odian, Bruce S. Bernstein, Robert Connolly,
Sidney Binder, and Dennis Beeferman

A STUDY OF THE MECHANISM OF RADIATION-INDUCED GELATION IN MONOMER-POLYMER MIXTURES

Radiation Applications Inc., Long Island City, N. Y.,
RAI-307, Aug. 1, 1962, Qtly. Summary Rpt., May 1 -
July 31, 1962, AT(30-1)-2816, 25 pp

The dose rate effect on the polymer-monomer radiation crosslinking system has been studied over the 0.015 - 4.0 Mrad/hr range and gel content has been

shown to be independent of the dose rate. This holds true for doses of 0.2 Mrads and above for Alathon 15 polyethylene equilibrium swollen at 25 C with allyl methacrylate prior to radiation. Tensile strengths of the monomer crosslinked systems appear to be at least equal to straight radiation crosslinked polyethylene. The dose-gel relationship for polyethylene-allyl acrylate has been elucidated over the range up to 12 Mrads and up to 63 Mrads for polypropylene-allyl methacrylate. The gel content has been shown to increase rapidly at first, level off slowly, and remain essentially constant after about 9 Mrads. Heat ageing studies of monomer-crosslinked polypropylene have shown these products to be superior to either untreated or straight irradiated polypropylene. Gel fractions have been obtained after irradiating polyisobutylene containing various amounts of allyl methacrylate. The effect of radiation dose (up to 3.2 Mrads) on equilibrium swollen polymer specimens (35 per cent allyl methacrylate) has been studied. Irradiation of samples containing smaller monomer levels has also been investigated.

18072

E. W. Hoyt and D. L. Zimmerman
RADIATION EFFECTS IN BORIDES PART II - FISSION SINTERING
OF BORIDE POWDERS
General Electric Co., Vallecitos Atomic Lab., San Jose,
Calif., GEAP-3743, Feb. 15, 1962, AT(04-3)-189, 18 pp
Avail: OTS

During the post-irradiation examination of the borides it was discovered that the samples which had been irradiated as powders had sintered into firmly bonded bodies. This radiation sintering occurred at temperatures hundreds of degrees below that required to produce similar interparticle bonding by the application of heat alone. This report discusses the results of the post-irradiation examination of some of these borides which were irradiated as powders and compares the results of our observations with the reports of similar radiation sintering occurring in other materials.

18073

A. J. Tuckerman and J. F. Yurk
DEVELOPMENT OF SELF-SEALANTS AND SEALANTS FOR AEROSPACE
VEHICLES
Hughes Aircraft Co., Culver City, Calif., Dec. 1, 1962,
Second Qtly. Rpt., Aug. 15 - Nov. 15, 1962, AF 33(657)-9171,
24 pp

A three compartment chemical self-sealant package has been developed which seals a "meteoroid" puncture .140 inches in diameter. Only two of the compartments of this package contain reactants, the third is left empty. Any of several polyurethane and epoxy reactions are workable with this system. Several polyurethane and a few polysulfide and silicone reactions have been evaluated with respect to their potential use as space-applied assembly sealants. An unfilled polyurethane system, which cures within six hours at room temperature under vacuum conditions, appears promising for this use.

18074

S. F. Singer, University of Maryland, College Park, Md.
NUCLEAR EXPLOSIONS IN SPACE
Nature, 196, (4852), Oct. 27, 1962, pp 307-314

Weapons tests in space create a thin shell of 2 Mev fission electrons the decay and diffusion of which can be studied, as well as the creation of a thick belt of low-energy protons from fusion neutrons. It will probably be desirable to monitor these artificial radiation belts with quite sophisticated energy-resolving detectors, to suppress the naturally trapped radiation, as well as the much larger changes (of factors of 10-100 and even higher) by such natural events as solar flares and magnetic storms.

18075

S. H. Pinner, BX Plastics Ltd.
POLYMERIZATION AND POLYMER MODIFICATION BY IONIZING
RADIATION
British Plastics, 35, (10), Oct., 1962, pp 518-525

This article surveys the literature published since 1958 on the application of ionizing radiation to the modification of plastics and to grafting and polymerization reactions. Although industrial utilization of high energy radiation has been slower than expected, at least two examples exist of the radiation processing of polythene on a large commercial scale, and increased awareness of the potential inherent in radiation modified shaped polymers is likely to lead to extended commercial exploitation.

18076

P. Jager and E. S. Waight, Imperial College, London, Eng.
GAMMA-RADIATION-INDUCED POLYMERIZATION OF p-N,N-DIMETHYL
LAMINOSTYRENE
Journal of Polymer Science, 59, (168), June, 1962,
pp S47-S48

Samples of p-N,N-dimethylaminostyrene were deaerated, sealed, and irradiated at -180, -78, 0, and 25 C to doses of 0.65, 1.70, and 7.0 Mrad. Results obtained indicate that the conversion rate has a maximum value in the temperature region just below the melting point and is considerably higher than the values obtained for the solid-state polymerization of styrene. Experiments carried out in the presence of oxygen gave rather erratic results, but the evidence obtained suggests that oxygen does not interfere with the propagation step.

18077

F. W. Mellows and Milton Burton, University of Notre
Dame, Notre Dame, Ind.
A KINETIC STUDY OF TELOMER PRODUCTION FROM CHLOROFORM-
ETHYLENE MIXTURES INITIATED BY COBALT-60 γ -RADIATION
Journal of Physical Chemistry, 6, (11), Nov., 1962,
pp 2164-2168

Radiolysis of chloroform-ethylene mixtures in an autoclave with doses in the range 5×10^{18} to 90×10^{18} ev ml⁻¹ produces the addition compounds C₂H₅CCl₃, C₄H₉CCl₃, and C₆H₁₃CCl₃ with G-values as high as 3000 at 100 degrees and 300 at 28 degrees. A study of product distribution as a function of ethylene pressure yields transfer constants for the radicals involved in the chain reaction: at 28 degrees the values for the radicals C₂H₄CCl₃, C₄H₈CCl₃, and C₆H₁₂CCl₃ are 0.21, 1.3, and 1.5, respectively; at 100 degrees they decrease to 0.15, 0.54, and 0.45.

18078

W.J.G. Beynon and E.S.O. Jones, University College
of Wales, Aberystwyth
IONOSPHERIC EFFECTS OF NUCLEAR EXPLOSIONS
Nature, 196, (4851), Oct. 20, 1962, pp 253-254

In the case of the large explosion of October 30, 1961, the minimum in electron density observed some 1-1/2 h after the explosion at four widely separated stations, ranging in distance 3,300-4,250 km from the source, marks the initial onset of the disturbance in the ionosphere. The time delay involved is just that to be expected for a rarefaction travelling at high level in the ionosphere from above the source with a sound-wave velocity appropriate to the mean temperature in the height-range 160-220 km. This phenomenon in the ionosphere, at large distances from the source, is only a feature of very large nuclear explosions and it may well depend too on the height at which the explosion occurred.

18079

C. Crouzet and J. Marchal, Center for Research on
Macromolecules, France
ACTION OF RADIOCOBALT γ RAYS ON AQUEOUS SOLUTIONS OF
POLYOXYETHYLENEGLYCOL (In French)
Journal of Polymer Science, 59, (168), June, 1962,
pp 317-320

The polymer solutions were irradiated in air to doses of 0.60, 1.630, 2.50, 0.435, and 1.13 Mrad. Results demonstrate the existence of two opposite mechanisms, the one leading to crosslinking of the polymer and the other to degradation.

18080

Kh. U. Usmanov, P. P. Larin, Yu. T. Tashpulator,
U. N. Musaev, and R. S. Tillaev
INFRARED SPECTRA OF POLYSTYRENE-ACRYLONITRILE AND
PERCHLOROVINYL-ACRYLONITRILE GRAFT COPOLYMERS PREPARED
WITH THE AID OF γ -RADIATION
Vysokomolekuliarnye Svedineniia, 4, (6), June, 1962,
pp 907-912, (In Russian)

The infrared spectra of polystyrene-acrylonitrile and perchlorovinyl-acrylonitrile graft copolymers prepared by the action of Cobalt-60 γ -rays have been investigated. The results showed that graft copolymers are obtained in both cases and that irradiation of perchlorovinyl alone followed by its thermal treatment in acrylonitrile leads to hydrolysis of the CN group of the monomer under the influence of the liberated HCl and moisture. The efficiency of the grafting reaction in this case is therefore much lower than on irradiation of the polymer and monomer together.

18081

M. Lazar, N. Kliman
POLYMERIZATION OF MONOCHLOROTRIFLUOROETHYLENE INITIATED
BY γ -RAYS
Vysokomolekuliarnye Svedineniia, 4, (6), June, 1962,
pp 948-952

The polymerization of monochlorotrifluoroethylene induced by γ -rays from a Cobalt-60 source at low dosage rates has been investigated. A rise in temperature causes a fall in the polymerization rate. The observed negative apparent activation energy has been discussed from different standpoints, the most likely cause of this being deemed to be degradation transfer of the monomer.

18082

R. N. Bashaw and B. G. Harper, Dow Chemical Co., Freeport,
Tex.

RADIATION-INDUCED CROSSLINKING OF POLYPOTASSIUM ACRYLATE
Journal of Polymer Science, 59, (168), June, 1962,
pp 221-231

The effects of a 0.81 Mrad dose on potassium acrylate and polypotassium acrylate and their aqueous solutions have been studied. In the presence of air and at high and low water concentrations, degradation is the predominant radiation-induced reaction. Crosslinking occurs at intermediate concentrations. The degree of crosslinking for a given dose reaches a maximum at a polymer concentration of about 60 per cent. An explanation of these results is presented.

18083

Adli M. Bishay, Argonne National Lab., Argonne, Ill.

ROLE OF CERIUM IN SUPPRESSION OF GAMMA-RAY INDUCED
COLORING OF BORATE GLASSES

Journal of the American Ceramic Society, 45, (8), Aug. 1,
1962, pp 389-393

The role of cerium in the suppression of gamma-ray induced coloration in glass has been found to depend on the relative concentration of Ce^{3+} to Ce^{4+} ions as well as on the total cerium content. The specimens were irradiated at room temperature in the dark at an incident intensity of 1×10^5 r per hour to doses of 7.4×10^6 r and 5.4×10^7 r. In a borate glass having high ultraviolet transmission, it has been found that both Ce^{3+} and Ce^{4+} ions are necessary to suppress the optical absorption bands induced in the visible region. The role of cerium can be explained on the basis of a change in its oxidation state as a result of gamma irradiation.

18084

N. Tamura, Japanese Association for Radiation Research
on Polymers, Tokyo, Japan

ESR SPECTRA OF POLYTETRAFLUOROETHYLENE IRRADIATED AT
77 K

Journal of Polymer Science, 60, (169), July, 1962,
pp S5-S7

In the present work the spectra were obtained from samples irradiated in vacuum at 77 K with electrons from a Van de Graaff accelerator. With the elevation of temperature, the spectrum was observed to vary both in shape and in intensity. The primary radicals produced by irradiation may be chiefly of the scission-type radical - CF_2 - CF_2 .

18085

J.V.F. Best, T. H. Bates, AERE, Harwell, Eng., and
T. Ffranon Williams, University of Toronto, Knoxville,
Tenn.

THE RADIATION-INDUCED POLYMERIZATION OF α -METHYLSTYRENE
Transactions of the Faraday Society, Part 1, 58, (469),
Jan., 1962, pp 192-205

A kinetic study of the polymerization of α -methylstyrene initiated by Cobalt-60 gamma rays is described. Using dry monomer at 30 C the mean initial yield corresponds to the conversion of 8000 molecules per 100 ev; the rate accelerates with increasing polymer formation and the polymerization proceeds almost to completion. A decrease in dose rate brings about a higher rate of polymerization per unit dose. In the range 0-30 C there is a slight increase of rate as the temperature is lowered; at 55 C the rate is considerably reduced. The addition of water in concentrations above 0.002 M to the system results in a very strong retardation of the rate by comparison with the dry reaction. The occurrence of facile chain transfer to monomer and the marked effect of water on the reaction rate are interpreted as evidence in favour of an ionic mechanism.

18086

A. Horsfield and J. R. Morton, National Physical Lab.,
Middlesex, Eng.

ELECTRON SPIN RESONANCE OF THE RADICAL $\text{CH}_3\text{OCHCO}_2$ IN
 γ -IRRADIATED POTASSIUM METHOXY-ACETATE

Transactions of the Faraday Society, Part 3, 58, (471),
March 62, pp 470-473

Single crystals of potassium methoxy-acetate trihydrate, irradiated with a 5 Mrad dose of 1 Mev γ -rays were examined by electron spin resonance. Under irradiation, hydrogen atoms are lost leaving the radical $\text{CH}_3\text{OCHCO}_2$ trapped in the crystal lattice in two magnetically distinguishable orientations. A characteristic coupling tensor, with an isotropic value of 50.0 Mc/sec, was obtained for the α -hydrogen. The methoxy-hydrogen coupling was small and unresolved in some crystal orientations but an approximate coupling tensor, with an isotropic component of 6 Mc/sec, was obtained.

18087

C. C. Klick and D. A. Patterson, NRL

COLORATION OF KCl AND KBr BY X-RAYS AT 4 K

Report of NRL Progress, July, 1962, pp 44-45

Measurements have been made into the vacuum ultraviolet on crystals of KCl and KBr colored by X-rays at 4 K. In each case two large bands were observed. One is the α -band due to halide ion vacancies; it is about eight times the size of the F-band. The other is close to the absorption edge and is about twenty times the size of the F-band. Both of these large bands bleach almost completely on warming to 77 K.

18088

C. H. Cheek, V. J. Linnenbom, and J. W. Swinnerton, NRL

EFFECT OF ACIDITY ON THE HYDROGEN YIELD IN GAMMA-IRRADIATED
AQUEOUS SOLUTIONS

Report of NRL Progress, July, 1962, pp 11-14

The yield of molecular hydrogen in gamma-irradiated aqueous solution has been measured as a function of acidity in the range from neutral solution to 10M sulfuric acid. All solutions contained 10^{-3} M bromide ion to protect the hydrogen from attack by OH radicals. The observed decrease in $G(\text{H}_2)$ with increasing acidity may be explained with the assumption that the gross number of radicals formed per unit absorbed dose is independent of pH, so that the increased radical yields in acid solution must occur at the expense of the hydrogen yield and the yield of recombined unlike radicals to form water.

18089

S. Okamura, K. Hayashi, and M. Nishii, Japanese Association
for Radiation Research on Polymers, Osaka, Japan
POLYMER CRYSTALS OBTAINED BY RADIATION POLYMERIZATION
OF TRIOXANE IN SOLID STATE
Journal of Polymer Science, 60, (169), July, 1962,
pp S26-S29

Trioxane was found to polymerize under gamma-irradiation very easily in the solid state, with no change in the outer appearance of the crystals. The polymerization was carried out at + 55 C. Some of the X-ray diagrams are reported here preliminarily as evidence for the apparent single crystal character of the product of the solid polymerization of trioxane.

18090

I. Mladenov, I. A. Tutorskii, and B. A. Dogadkin,
Moskowskii Institute Tonkoi Khimicheskoi Tekhnologii,
Moscow, U.S.S.R.
REACTIONS OF CARBOXYLATED BUTADIENE-STYRENE RUBBERS AND
THEIR MIXTURES WITH ϵ -CAPROLACTAM INDUCED BY γ -RADIATION
Journal of Polymer Science, 61, (171), Sept., 1962,
pp 235-242

Carboxylated butadiene-styrene rubber containing various amounts of styrene and methacrylic acid were exposed to 0.1-50 Mr doses of γ -radiation from a Cobalt-60 source in an atmosphere of argon. This irradiation resulted in a decrease in the carboxyl group content, particularly at low doses. The radiochemical yield of crosslinked polymers at low doses is a linear function of the carboxyl group content of the initial polymer. The number of crosslinks formed by the carboxyl groups at doses up to 20 Mr calculated from the maximum swelling data was found to agree satisfactorily with the number of crosslinks as calculated from the carboxyl group consumption. Irradiation of the carboxylated rubber in mixtures with ϵ -caprolactam gives rise to addition of the latter to the rubber with formation of insoluble compounds. The amount of caprolactam combining with the rubber increases linearly with an increase in ϵ -caprolactam content of the original mixtures in the range of 5-50 per cent. There is also an increase in the degree of crosslinking. An increase in the bound ϵ -caprolactam content leads to an increase in the tensile strength of the polymer.

18091

A. Charlesby and D. K. Thomas, Royal Military College
of Science, Wilts, Eng.
A COMPARISON OF THE EFFECTS OF ULTRA VIOLET AND GAMMA
RADIATION IN POLYMETHYLMETHACRYLATE
Proceedings of the Royal Society, Series A, 269,
(1336), Aug. 21, 1962, pp 104-124

The exposure of polymethylmethacrylate (PMM) and many other macromolecules to high-energy γ - or electron radiation produces a degradation of the molecular chains. This may result from either ionization or excitation. Ultra-violet light results in excitation only. The degradation of PMM has been studied in thick or thin films, and in solutions in benzene. It is found that at room temperature degradation (random main chain fracture) occurs with ultra-violet radiation, whereas at higher temperatures the reaction is one of chain depolymerization. The

two reactions are very similar; in both cases the number of fractures is proportional to dose and the radicals formed are identical in character. Somewhat similar changes also appear in the optical spectrum, although these may be modified by surface oxygen. These results show no significant contribution from any ionization produced by high-energy radiation.

18092

C. C. Hsiao and J. W. Yang, University of Minnesota,
Minneapolis, Minn.

EFFECT OF INITIAL STRAINING AND γ IRRADIATION ON
STRENGTH OF POLYETHYLENE

Journal of Applied Physics, 33, (9), Sept., 1962,
pp 2870-2872

Uniaxially and biaxially oriented samples of polyethylene irradiated by γ - rays at 78 F for different durations to obtain three different dosages: 1.77×10^7 rep, 3.21×10^7 rep, and 9.44×10^7 rep, have been investigated at room temperature. Both the tensile strength and the modulus of elasticity are found to increase as the degree of orientation induced by homogeneous deformation increases. But the tensile strength decreases as the dose of γ irradiation increases while the modulus of elasticity increases. The combined effects seem to indicate that the γ irradiation essentially destroys the macromolecular orientation and thus reduces the tensile strength to that of unoriented solid, but with relatively higher elastic modulus as a result of the occurrence of crosslinking.

18093

B. S. Hickman, T. M. Sabine, Australian Atomic Energy
Commission Research Establishment, Australia, and
R. A. Coyle, Aeronautical Research Labs., Dept. of
Supply, Australia

X-RAY DIFFRACTION STUDIES OF IRRADIATED BERYLLIUM OXIDE

Journal of Nuclear Materials, 6, (2), July, 1962,
pp 190-198

The lattice parameter changes which occur on neutron irradiation of hot pressed beryllium oxide to integrated fission neutron doses of 1×10^{19} nvt to 3.5×10^{20} nvt at 75-100 C and to doses of $1-1.5 \times 10^{20}$ nvt at 500-650 C are reported. The lattice expansion at irradiation temperatures of 500-600 C is almost a factor of three smaller than for equivalent neutron doses at 75-100 C. At doses of 3.5×10^{20} nvt and above at temperatures of 75-100 C, crumbling and cracking of the specimens occurs because of the intergranular stresses caused by the anisotropic expansion. The annealing behaviour of the lattice parameter changes is described and it is shown that temperatures of 1400-1500 C are required for complete recovery of the damage to occur. Line broadening effects are discussed in a qualitative manner and it is suggested that defect clusters are formed in the basal planes of the hexagonal beryllium oxide lattice.

18094

John P. Guarino, Michael R. Ronayne, and William H.
Hamill, University of Notre Dame, Notre Dame, Ind.

SOLUTE COMPETITION FOR THERMAL ELECTRONS IN GAMMA-
IRRADIATED ORGANIC GLASSES AT -196 C

Radiation Research, 17, (3), Sept., 1962, pp 379-387

Comparison of the absorption spectra in tetrahydro-2-methylfuran at -196°C of alkali naphthalenide or biphenylide with γ -irradiated solutions of naphthalene or biphenyl demonstrates electron attachment in the latter. Gamma-irradiated glassed solutions in hydrocarbons show the same effect. Including a second solute which competes for electrons in γ -irradiated samples decreases $G(\text{naphthalenide})$ or $G(\text{biphenylide})$ and provides a measure of the electron-attaching efficiency of the second solute; twenty-seven solutes were tested, some in two solvents.

18095

H. D. Heinze, K. Schmieder, Gg. Schnell, and K. A. Wolf,
Badische Anilin- & Soda-Fabrik A. G. Ludwigshafen,
Rhein, Ger.

THE TEMPERATURE SHIFT OF THE SECOND ORDER TRANSITION
OF NATURAL RUBBER BY CROSSLINKING

Rubber Chemistry & Technology, 35, (3), July-Sept., 1962,
pp 776-793

Dynamic mechanical and infrared spectroscopic tests were performed on natural rubber crosslinked by sulfur, peroxide or 2 Mev electrons in a nitrogen atmosphere. The effect of these vulcanization methods upon the rate of crosslinking, the position of the second order transition temperature and the double bond structure is discussed. Vulcanization by sulfur and crosslinking by irradiation appear, principally, to be based on the same mechanism. The influence of oxidation on the mechanical properties of the vulcanizates is studied in natural rubber irradiated in an oxygen atmosphere. The two damping maxima observed at the dynamic mechanical test can be ascribed, with the aid of infrared spectroscopy, to the influence of crosslinks and oxidation products on the chain mobility.

18096

Kakuji Yamamoto and Masao Tsuchiya, Tokyo Metropolitan
Isotope Center, Tokyo, Japan
ELECTRIC CHARACTERISTICS OF GAMMA-RAY IRRADIATED SHIELDING
WINDOW GLASS

Journal of Applied Physics, 33, (10), Oct., 1962,
pp 3016-3020

Induced color of shielding window glass of various kinds by γ -ray irradiation is studied. With Cobalt-60 1 kc as radiation source, $23 \pm 3^{\circ}\text{C}$ as irradiation temperature, 10^5 R/h as exposure dose rate and 10^5 - 10^7 R as total exposure dose, the coloration increases gradually. Volume resistivity of glass and its change by gamma-ray irradiation are measured. 100 V dc is applied to a sheet of glass sandwiched between two electrodes to measure the change of its electric resistance with time. The quantity of induced space charge by radiation is calculated by time integration of the current which is obtained from reciprocal of the resistance. Resistance of high density glass is found to become minimum--hence the current becomes maximum--at the exposure dose of 10^6 R and increases as the dose increases, but resistance of medium density glass decreases gradually. Change of the resistance is exponential and the charge is always positive at any dose. This testifies that glass is electrized by radiation. On the other hand, linearity is established between the quantity of space charge and the dose in a range of 10^5 to 4×10^6 R. This suggests the possibility of the electrization to be utilized for dosimetry.

18097

D. M. Sandomirskii, V. L. Karpov, V. G. Yurkevich
RADIATION VULCANIZATION OF RUBBER IN LATEX
Vysokomolekuliarnye Soedineniia, 4, (7), Aug., 1962,
pp 1064-1070, In Russian

The action of γ -rays on natural and synthetic latexes (polychloroprenic, butadiene-styrenic and butadiene-nitrilic) causes structuration of the polymer with corresponding upgrading of its physicomechanical properties. The optimal dose for natural latex is about 20 meg r. The radiation crosslinking of polymer molecules in the latex takes place more rapidly than in solid rubber, apparently due to the action of radiolysis products of water. In a latex formed with nekal, structuration is slower than in a latex stabilized by fatty acids salts. The action of radiation on latex as a colloidal system depends upon the concentration and nature of the latex. Concentrated polychloroprene latex gels on irradiation; in natural latex the globules aggregate and the latex thickens. Irradiation has no effect on the dispersity or stability of dilute latexes.

18098

Z. N. Tarasova, M. S. Fogelson, V. T. Kozlov, A. I.
Kashlinskii, M. Ya. Kaplunov, B. A. Dogadkin
EPR STUDY OF THE RADIATION VULCANIZATION OF RUBBER IN
THE PRESENCE OF SULFUR AND HEXACHLOROETHANE
Vysokomolekuliarnye Soedineniia, 4, (8), Aug., 1962,
pp 1204-1209, (In Russian)

The EPR spectra of natural rubber (NR) and its mixtures with hexachloroethane and sulfur show the presence of long life free radicals on γ -irradiation at 20 C. On irradiation at -196 degrees the radicals formed possess various longetivities. On heating these specimens structuration is observed in the region of -70 degrees, this effect being accompanied by a decrease in free radical concentration to that characterizing the specimens irradiated at 20 degrees. Crystalline S gives a weak EPR signal on irradiation; it lowers the initial radical concentration in NR + S mixtures irradiated at -196 degrees and diminishes the low temperature structuration effect. Sulfur augments the static strength of the radiation vulcanizates. An increase in the EPR line intensity is observed on irradiation of C_2Cl_6 , indicating the presence of several types of free radicals. Hexachloroethane increases the initial radical concentration in a mixture of NR + S + C_2Cl_6 irradiated at -196 degrees and enhances the structuration effect of the rubber.

18099

F. S. Dainton and F. T. Jones, University, Leeds, Eng.
ASPECTS OF THE RADIATION CHEMISTRY OF FLUID AND RIGID
AQUEOUS SOLUTIONS CONTAINING NITROUS OXIDE AND
FERROUS IONS
Radiation Research, 17, (3), Sept., 1962, pp 388-398

Measurements have been made of $G(N_2)$, $G(H_2)$, and $G(O_2)$ for solutions of N_2O in aqueous mineral acids of varying composition over the temperature range 77 to 350 K. Whenever a change in condition causes a transition from a crystalline or a fluid state to a glassy state, $G(N_2)$ increases abruptly but $G(O_2)$ and $G(H_2)$ are largely unaffected. Yields of Fe^{3+} , N_2 , and H_2 have been measured when 5 M H_2SO_4 glasses at 77 K containing Fe^{2+} and N_2O are irradiated with 2537-A light or Cobalt-60 γ -rays. These results and E.S.R. and low-temperature spectrophotometry data are all consistent

with the hypothesis that electrons generated in the primary act migrate distances of about 50 Å in the glass and will always react with any solute (N_2O or Fe^{2+}) they encounter during this migration.

18100

E. Lell, Bausch & Lomb Inc., Rochester, N. Y.

RADIATION EFFECTS IN DOPED FUSED SILICA

Physics and Chemistry of Glasses, 3, (3), June, 1962,
pp 84-94

Fused silica was prepared doped with alkali oxides alone and in combination with aluminum or gallium, and the effects, 2×10^5 , 1×10^6 , and 5×10^7 rads, of γ -irradiation were studied. Alkalies alone cause an absorption band of 2050 Å; no such band was observed when aluminum was present with the alkali. Both effects suggest a formation of alkali-aluminum pairs. The absorption spectrum of fused silica doped with aluminum and alkali and exposed to radiation can be resolved into six Gaussian bands. The simultaneous presence of aluminum and alkali is necessary to obtain strong coloration at 2.25 eV (5500 Å) for exposures less than 5×10^6 rad. However, specimens doped only with high amounts of aluminum do yield this band at higher exposures. The substitution of gallium for aluminum results in a strong band at 5.5 eV (2240 Å) in unexposed specimens. Exposure causes the band at 2.3 eV (5400 Å) and a band at 5.05 eV (2550 Å), and probably more bands which have not been resolved. Heat treatment changes the relative intensity and growth rate of the radiation-induced bands.

18101

A. S. Kuzminskii, L. S. Ruzer and L. L. Sunitsa,

Scientific Research Institute of the Rubber Industry,
USSR

COBALT-60 SOURCE OF GAMMA-RADIATION WITH AN ACTIVITY OF

10,000 CURIES FOR RADIO-CHEMICAL STUDIES OF RUBBERS

Soviet Rubber Technology, 20, (11), Nov., 1961, pp 9-11

Studies have recently been made at the Scientific Research Institute of the Rubber Industry on the action of ionising radiation on the properties of raw rubbers, vulcanisates and rubbery materials. Equipment was introduced in January, 1959, having a radioactive Cobalt-60 source with a power of approximately 10000 curies (16000 gram-equivalent of radium). To improve the radiation resistance of vulcanisates an extensive study of the mechanism of radiation ageing and the action of antirads was made.

18102

RADIATION-RESISTANCE OF "TEFLON" RESINS IN VACUUMS IS
VERIFIED

Journal of Teflon, 3, (8), Sept.-Oct., 1962, p 2

The ultrahigh vacuum system consisted of an ion pump and a liquid-nitrogen-series cold trap. The strips of "Teflon" tape were placed in a "Pyrex" tube which was then fused to an ultrahigh vacuum system. The tape was heated to 70 C, using an infrared lamp at a pressure of 8×10^{-9} mm Hg for 4 days. The tube was then fused from the apparatus in such a manner that vacuum was maintained in the tube. Three evacuated tubes were prepared in this manner and exposed to a Cobalt-60 source in the Hughes Nucleonics Laboratory. After analysis, these tests proved

that "Teflon" has superior high-and-low-temperature characteristics, has nearly the same coefficient of friction in vacuum as in atmosphere, and has good dielectric properties. These characteristics coupled with good radiation resistance in vacuum make "Teflon" a valuable material for many space-vehicle applications.

18103

J. T. Walbert and J. C. Reed
"TEFLON" FLUOROCARBON RESINS IN SPACE ENVIRONMENTS
E. I. Du Pont de Nemours & Co., Wilmington, Del.,
Paper, 8 pp

"Teflon" resins retain to a high degree, their excellent mechanical and electrical properties under conditions usually considered representative of space applications. Unlike most polymers, "Teflon" resins contain no organic plasticizers, flame retardant compounds, crosslinking agents, etc. which might outgas or degrade radiation resistance. The commonly used pigments and reinforcing agents in "Teflon" are inorganic in nature and, hence, do not limit the applicability of the polymer in space. The effects of radiation and vacuum are briefly reviewed.

18105

Ed. F. Degering
IRRADIATION "FACTOR DEPENDENCY": EXPLORATORY STUDIES
AND IRRADIATION-INDUCED POLYMERIZATION OF STYRENE
U. S. Army Quartermaster Research and Engineering Center,
Natick, Mass., Preprint, Presented at the Second
International Congress of Radiation Research, Harrogate,
Eng., Aug. 5-11, 1962, 32 pp

Additive, atmosphere, dose rate, dose level, irradiation or time cycle, traces of oxygen or moisture, and temperature are significantly important variables for the electron-induced polymerization of styrene, under conditions employed in these studies. These observations have been confirmed, in general, for other vinyl monomer systems, but the extent of the effect varies with the monomers.

18106

PROCEEDINGS: INTERNATIONAL SYMPOSIUM ON RADIATION-
INDUCED POLYMERIZATION AND GRAFT COPOLYMERIZATION
Battelle Memorial Institute, TID-7643, Nov. 29-30, 1962,
413 pp
Avail: OTS

The following papers were presented: irradiation "factor-dependency" of vinyl monomers; effects of some experimental variables, the effect of additives on the low temperature Cobalt-60 initiated polymerization of isobutene, radiation-induced polymerization of ketene and its derivatives, radiation-induced polymerization of alpha-olefins, Cobalt-60 gamma radiation polymerization of ethylene, polymerization at high pressures, initiated with gamma rays, radiation-induced ionic polymerization of butadiene, the radiation-induced polymerization of cyclopentadiene at -78 C, effect of oxygen on radiation polymerization in solid solutions of acrylamide-propionamide, radiation initiated polymerization in the solid state, the mechanisms of radiation induced solid state polymerization of cyclic monomers, studies of polymerization in the crystalline state, gamma-initiated crosslinking of unsaturated polyesters, grafting of vinyl pyrrolidone to poly-

methacrylate by irradiation techniques -- peroxide initiation, radical stability and reactions, ESR studies of the decay of free radicals in irradiated polyethylene, kinetic features of graft copolymerization with special reference to radiation grafting, accelerative effects in radiation-induced graft polymerization, radiation crosslinking of polymers via polyfunctional monomers, radiation induced grafting to cellulose and its derivatives, modification of textile fiber properties by radiation-induced graft polymerization Part 1 the application of vinyl monomers by a vapor-phase technique, modification of textile fiber properties by radiation-induced graft polymerization Part 11 diffusion and kinetics in radiation-induced graft polymerization, radiation-induced graft polymers of cellulose, preparation of wood-plastic combinations using gamma radiation to induce polymerization, grafting of chloromethylstyrene to polypropylene fibers by the use of ionizing radiation, and graft copolymers of polyethylene and acrylic acid.

18107

Arthur A. Armstrong, Jr., and Henry A. Rutherford,
North Carolina State College, School of Textiles,
Raleigh, N. C.

MODIFICATION OF TEXTILE FIBER PROPERTIES BY RADIATION-
INDUCED GRAFT POLYMERIZATION. Part 1. THE APPLICATION
OF VINYL MONOMERS BY A VAPOR-PHASE TECHNIQUE

Presented at the International Symposium on Radiation-
Induced Polymerization and Graft Copolymerization,
Battelle Memorial Institute, Columbus, O., TID-7643,
Nov. 29-30, 1962, 58 pp

Avail: OTS

A procedure that proved successful for the application of acrylonitrile to cotton involved the addition of the monomer from the vapor phase. Subsequently, a number of volatile vinyl monomers was added to various fiber substrates in this fashion. The vapor-phase process for grafting, some of the conditions that tend to accelerate grafting, and some of the properties of grafted fibers are described. Cobalt-60 was used as the radiation source, the dose rate being about 4.0×10^5 roentgens per hour at the center. As the dose of radiation was increased and as the amount of monomer in the vapor was increased, the addition of polymer became greater. The relative breaking loads of the various yarns were determined as a function of the time of irradiation, and of the amount of acrylonitrile added. The amounts of vinyl monomers added to various fibers during an exposure period of two hours (7.6×10^5 roentgens) are shown. Relatively small amounts of acrylonitrile grafted to cotton by the procedure described here produced a material extremely resistant to cellulose-destroying microorganisms. When cotton cloth is grafted to the extent of 4 per cent of acrylonitrile by the vapor-phase irradiation technique, there is no noticeable change in hand or color of the materials.

18517

MERCURY CORROSION LOOP TESTING PROGRAM

Aerojet-General Corp., Azusa, Calif., AGC-0584-04-5,
Jan., 1963, NAS 3-1925, 13 pp

This report describes the fabrication, testing, and analysis work accomplished during the fifth quarter of a program to provide information on the corrosion resistance of the materials selected for the SNAP-8 mercury system. A testing program was started to determine the clearances required for the most efficient

operation of each Haynes 25 pump. Haynes 25 pump No. 4 is currently being tested. Tubing for Loop No. 2 was fabricated, and the loop was assembled. Assembly will be completed when further data from Loop No. 1 tests are available. Design of the follow-on corrosion loops was initiated. Development of techniques for fabrication of loops constructed of Cb-1 per cent Zr tubing clad with 316 SS was started.

18518

STUDY OF EFFECT OF HIGH-INTENSITY PULSED NUCLEAR
RADIATION ON ELECTRONIC PARTS AND MATERIALS

International Business Machines Corp., FSD Space
Guidance Center, Owego, N. Y., IBM-63-521-1,
Rpt. No. 9, July 1 - Sept. 30, 1962, DA 36-039-
SC-85395, 50 pp

Avail: ASTIA

Experiments were conducted at the Sandia Pulsed Reactor to verify the hypothesis that photoconductivity is a major component of the current induced by nuclear radiation in glass-dielectric capacitors. The results are inconclusive due to component-response variations which are attributed to internal defects in the capacitors. Also discussed are the post-irradiation investigations that led to the discovery of the capacitor defects, and which showed that the variations in component response could have been caused by these defects. A discussion of the theory and results of the previous SPRF experiment that suggested the hypothesis for this test series is given in Section II. The results of this test series are given in Section III, together with the results of flash X-ray experiments conducted at the IBM flash X-ray source. These latter experiments were performed to check variations in component response indicated by the SPRF data. General test procedures and test equipment are described in Section IV. As in the previous test series, the capacitors tested were constructed specifically for this experiment.

18519

Ernest R. Jervis, et al

INVESTIGATION OF FACTORS AFFECTING EARLY EXPLOITATION
OF INTEGRATED SOLID CIRCUITRY

ARINC Research Corp., Washington, D. C., ASD-TDR-7-998-2,
Interim Tech. Doc. Prog. Rpt., Oct. 12, 1962 - Jan. 1,
1963, AF 33(657)-8785, 110 pp

Avail: ASTIA

Investigations of the various research, engineering, logistic, and economic factors that enter into adoption of the integral electronic concept in military electronic systems are continuing. Manufacturing processes are being assessed in relation to their effect on producibility and reliability of the end product. Additional research development, and manufacturing methods needed for effective utilization of this technology in advanced weapons systems during the 1963-1970 period will be recommended. Numerous problem areas are discussed, and tentative conclusions and recommendations are made covering many of the problem areas.

18520

J. R. Bilinski, E. H. Brooks, U. Cocca, R. J. Maier,
and D. W. Seigworth

PROTON-NEUTRON DAMAGE CORRELATION IN SEMICONDUCTORS

General Electric Co., Radiation Effects Operation,
Defense Systems Dept., Syracuse, N. Y., June 10,
1962, Final Rpt., Nov. 24, 1961 - June 1, 1962,
NAS 1-1595, 12 pp

A study program to determine a proton-neutron damage correlation in semiconductors is presented. Three approaches were undertaken: theoretical, empirical using data from existing literature, and experimental. The theoretical studies show that damage processes between the neutrons and protons are basically different in silicon. In the empirical study using the data from the literature, it was not possible to determine a reliable proton-neutron correlation. The experimental program was carried out on silicon solar cells under fission and moderated neutrons and proton energies of 48.5, 68.9, and 96.5 Mev. A proton-neutron correlation for the diffusion length damage was determined and the ratios of the proton to neutron damage varied from 0.6 to 4.8 depending on the proton energy and neutron spectrum.

18521

Edwin T. Hunter and Harry E. Wannemacher
TRANSIENT AND STEADY-STATE NUCLEAR RADIATION EFFECTS
ON GERMANIUM PNP ALLOY TRANSISTORS
U. S. Army, Electronics Research and Development Lab.,
Fort Monmouth, N. J., USAELRDL-TR-2310, Oct., 1962,
Tech. Rpt., 7 pp
Avail: ASTIA, OTS

Procedures and results of nuclear irradiations made on germanium alloy transistors are reported. The facilities used were the Pennsylvania State University Reactor and the Sandia Pulsed Reactor. Transient results of, collector-base leakage current, I_{CBO} , changes indicate dependence on applied voltage, with a resultant effective shunt resistance of 200 K. Changes in gain and in minority carrier lifetime were used to compute damage constants from data taken at both facilities. A factor of three is observed between the constants. Leakage current measurements and gain measurements are reported as functions of cutoff frequency, f_{α} .

18522

D. B. Ebeoglu and A. J. Saur
TRANSIENT RADIATION EFFECTS IN ELECTRONIC MATERIALS
North American Aviation, Inc., Atomics International,
Canoga Park, Calif., NAA-AI-7860, Dec. 26, 1962,
Third Qtly. Rpt., Aug. 1 - Oct. 31, 1962, MIPR-R-
62-16-SC-00-93, 33 pp
Avail: ASTIA

Preliminary tests have been carried out to determine the extraneous signals generated in the various components of the test circuit. The tests were performed on various combinations of components of the apparatus. The main problem has been to reduce the magnitude of the noise signals induced in the copper tubing which formed the extended electrodes. These tests included comparison of data between circuits with and without an MgO sample. The results of these tests indicate that the transient leakage currents are still much larger than the current through the sample. This leakage must be reduced in order that the transient current may be observed through the insulator sample. At present polyethylene samples are being tested in a modified sample holder and electrode arrangement designed to decrease the shunt currents to admissible levels. The KEWB has been the facility utilized in this investigation.

18523

J. R. Burnett, Z. Azary, and C. W. Sandifer
FLASHING LIGHT SATELLITE SYSTEM FOR SNAP RADIATION
ENVIRONMENTS

Edgerton, Germeshausen & Grier, Inc., Santa Barbara,
Calif., EGG-S-227-R, Jan., 1963, AF 19(628)-495,
41 pp

A study of design modifications (Phase I) has been performed on the EG&G Flashing Light Satellite System for reliable operation in a nuclear radiation environment. The purpose of Phase I was to: (1) examine the components and materials of the present system and recommend radiation-tolerant replacement items where necessary; (2) conduct a nuclear test program on present and replacement items which are sensitive to radiation effects, and determine their exact degradation in the SNAP radiation environment; (3) recommend components, materials, construction techniques, and circuit modifications to be used in constructing the radiation-tolerant system for SNAP applications. The initial exposure was performed at the Battelle Memorial Institute reactor at a low power level and at a distance from the core face. The dose received by the components was neutron - 4.8×10^{12} n/cm², $E > 0.5$ Mev and gamma - 7.1×10^7 ergs/cm(C), $E_{\text{average}} \sim 1.0$ Mev. Capacitors, diodes, rectifiers, Zener diodes, transistors, and resistors were irradiated. The parameters measured included capacity, dissipation, leakage current, collector leakage current, and collector to base breakdown voltage.

18524

G. R. Harrison and J. P. Scheiwe
STUDY OF PULSED RADIATION EFFECTS ON MICROWAVE FERRITE
DUPLEXERS

Sperry Rand Corp., Sperry Microwave Electronics Co.,
Clearwater, Fla., SJ 222-0041-2, Nov., 1962, Second
Qtly. Rpt., Aug. 1 - Oct. 31, 1962, DA-36-039-SC-89113,
35 pp

Avail: ASTIA

Experiments were performed to obtain data regarding air ionization susceptibility of various cable types and configurations and radiation effects caused by irradiation of individual operating ferrite duplexer components. Procedures are described for testing C-band microwave coaxial ferrite Y-junction circulators, gyromagnetic-coupling limiters, and ferrite isolators during the initial series of experiments conducted at Sandia Pulsed Reactor Facility. Photographs of oscilloscope traces showing radiation effects on operating characteristics of these components are presented. Quantitative interpretations of the data obtained by circuit calibration procedures are also presented. The radiation effects on two types of cable configurations - flexible RG-5B/U and semi-flexible Spirafil are also displayed pictorially and reported quantitatively. The air dielectric Spirafil cable increases in breakdown susceptibility with a decrease in internal air pressure. Results of dosimetry provided by the SPRF are tabulated along with components investigated in each test.

18525

J. C. Corelli and D. M. Amorosi
ANNEALING OF NEUTRON RADIATION DAMAGE IN p-TYPE PbTe

General Electric Co., Knolls Atomic Power Lab.,
Schenectady, N. Y., KAPL-2226, Jan., 1962, W-31-109-
Eng-52, 31 pp

The measurement of conductivity, Seebeck, and Hall coefficient changes in p-type PbTe caused by reactor irradiation has been extended in a specimen to a reactor-radiation dose of 4.4×10^{19} neutrons/cm² with energy greater than 1 Mev and a thermal-neutron dose of 1.5×10^{21} neutrons/cm². Sample temperature during irradiation was 60 ± 20 C. Permanent changes caused by thermal-neutron transmutations were negligible (< 3 per cent), indicating that all the damage is annealable and caused by fast neutron-induced defects. Based on previous irradiation test results and those which follow, we are presenting a phenomenological model which predicts the behavior of n- and p-type PbTe at possible operating temperatures during reactor irradiation. The carrier-concentration decrease caused by irradiation of the specimen was a factor of 5.3 less than the pretest measurement. This factor accounts for most of the increase in Seebeck coefficient (factor 2.9). Analysis of the annealing effects on electrical conductivity (decreased by a factor 7.6) yields an activation energy for defect migration of ≈ 0.55 ev. Isothermal annealing experiments indicate the simultaneous recovery of conductivity, Hall, and Seebeck coefficients for temperatures in the range 88 to 162 C.

18526

William C. Honaker and Floyd R. Bryant
IRRADIATION EFFECTS OF 40 AND 440 MEV PROTONS ON TRANSISTORS
NASA-Langley Research Center, Langley Station, Hampton,
Va., NASA-TN-D-1490, Jan., 1963, Tech. Note, 42 pp
Avail: NASA, OTS

Several types of transistors were irradiated with 40 and 440 Mev protons by utilizing the 40 Mev linac accelerator at the University of Minnesota and the 440 Mev synchrocyclotron at the Carnegie Institute of Technology. The measurement of transistor parameters before, during, and after irradiation is presented in both graphic and tabular form as a function of integrated flux. The data presented indicate that the 40 Mev protons are more effective in producing damage than the 440 Mev protons. Most of the damage due to 40 Mev protons occurred below an integrated proton flux of 10^{12} protons/cm². The transistors having a higher alpha cutoff frequency proved to be more resistant to radiation.

18527

R. S. Caldwell
SOME RECENT RESULTS CONCERNING TRANSIENT RADIATION
EFFECTS IN TRANSISTORS
Boeing Airplane Co., Seattle, Wash., D2-90040, Sept. 21,
1961, AF 33(616)-7804, 22 pp
Avail: ASTIA

A new empirical relationship has been developed to explain the response of transistors to a pulsed radiation environment. This relationship represents a phenomenon of secondary photo-currents which is particularly important in describing the response of transistors to short high-intensity radiation pulses. This result essentially adds a second term to the existing expression. The Boeing Flash X-ray facility was used in these studies on 2N1099, 2N336, and 2N393 transistors.

18528

J. F. Weller, Naval Research Lab.
PROTON DAMAGE TO SILICON SOLAR CELLS
Report of NRL Progress, Jan., 1962, pp 1-6

Several types of silicon solar cells have been irradiated with approximately 4.8 Mev protons. Variations in the cells irradiated in the experiment were bulk material, impurity concentration, and oxygen concentration. Changes in diffusion length, spectral response, and current-voltage characteristics show that the n/p cell is more radiation resistant than the p/n. No difference in radiation resistance is seen by varying the oxygen concentration, but there is a trend toward increased radiation resistance as the resistivity of the bulk is increased.

18529

D. S. Peck, R. R. Blair, W. L. Brown, and F. M. Smits
SURFACE EFFECTS OF RADIATION ON TRANSISTORS
The Bell System Technical Journal, 42, (1), Jan., 1963,
pp 95-129

Observation of surface effects of ionizing radiation on several types of transistors indicates that in reverse-biased devices these effects occur at much lower radiation dosage than in unbiased devices or bulk semiconductor material. Further, the total radiation dose rather than dose rate seems often to be the more important factor in the effect. The type of particle used in irradiation is unimportant; the significant factor is the ionization it produces. The effects seem to arise from ionization of gases within a transistor encapsulation and interaction between the ionized gas and residual semiconductor surface contaminants. This results in inversion layers at the device surface and thus in alteration of junction characteristics. The changes in device properties are not permanent, but the recovery after removal from radiation is complex and proceeds with characteristic times between seconds and days. Different types of devices may respond quite differently to exposure, and the response is different even between different batches and individuals, indicating a dependence upon device processing.

18530

Leonard B. Gardner, Northrop Space Laboratories,
Hawthorne, Calif.
SELECTING ELECTRONIC COMPONENTS FOR SPACE RADIATION
Electromechanical Design, 7, (1), Jan., 1963, pp 32-38

This article discusses the selection of electronic components for application in a space radiation environment. The selection is primarily based upon favorable reports in the literature respecting the components' performance in pulsed and steady state radiation environments of mixed neutrons and gamma rays. Secondary consideration is given to the differing degree of damage between these environments, i.e. between space radiation and mixed neutron and gamma ray radiation. In certain instances, the reports of component tests have been modified to conform with expected results in space radiation. In these instances the modification is based upon the various mechanisms of radiation damage and experience in radiation testing. No attempt is made herein to correlate the energy dependence of damage between the various environments.